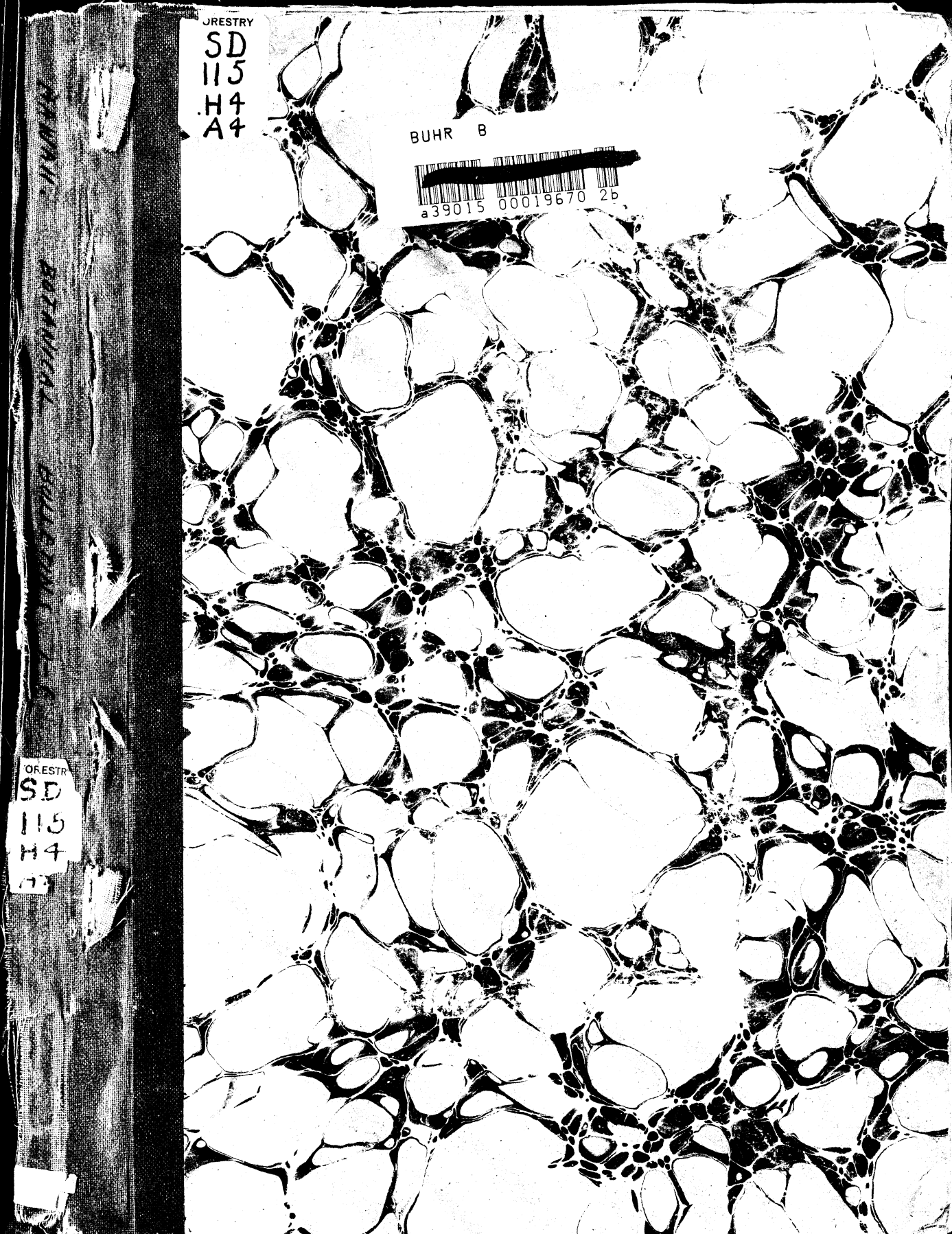
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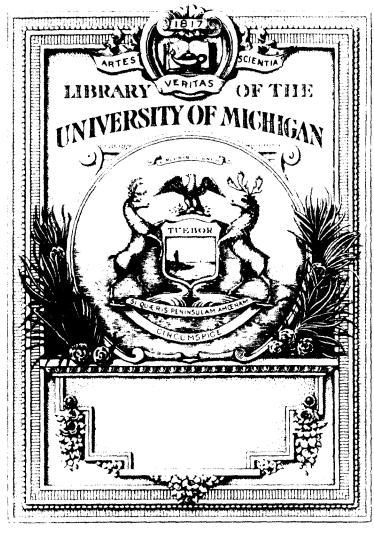

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BOTANICAL BULLETIN NO. 1 SEPTEMBER, 1911

TERRITORY OF HAWAII
BOARD OF AGRICULTURE AND FORESTRY
DIVISION OF FORESTRY

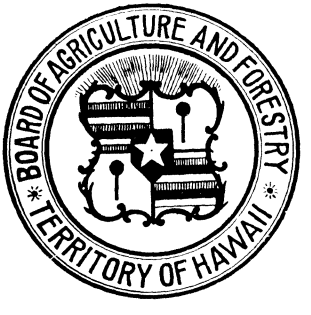
New and Noteworthy Hawaiian Plants

BY

DR. L. RADLKOFFER,
Munich (Germany)

AND

J. F. ROCK
From the Division of Forestry, Board of Agriculture and Forestry, Honolulu, T. H.



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NEW AND NOTEWORTHY HAWAIIAN PLANTS.

By Dr. L. Radlkofer and J. F. Rock.

Alectryon macrococcus Radlkofer in Sitzungsber. K. Bayer. Ac. XX (1890) p. 255 et in Engl. & Pr. Pfl.-Fam. III, 5 (1895) p. 333.—Mahoe, gen. nov.? Hillebr. Fl. Haw. Isl. (1888) p. 86.—Dodonaea sp. Drake del Cast. Ill. Fl. Ins. Mar. Pacif. (1890) p. 144 in obs. ad. Dod. visc.—Vulgo *Mahoe* in Molokai teste Hillebr. l. c. (quo nomine in Novo-Zealandia Melicytus ramiflorus Forest. salutatur t. Kirk in Forest Fl. N.-Zeal., 1889, p. 3).

Arbor mediocris; rami teretes, rubri—fusci, glabrati, juveniles striati, cum foliis novellis tomento adpresso sericeo flavescenticano induti; folia 2—5—juga; foliola magna, opposita, elliptica vel subovata, utrinque obtusa vel apice acuminata (t. Hillebr.), petiolulata, integerrima, undulata, coriaceo-chartacea, nervis lateralibus sat approximatis obliquis subtus ut et nervo mediano valido dilatato supra plano prominentibus, glabra (vel subtus t. Hillebr. laxe tomentosa), utrinque nitidula, sicca e viridi subfusca, epidermide non mucigera paginae superioris hypodermate suffulta; paniculae axillares, basi ramosae, parvae; flores—(ignoti); fructus 1—coccus, adhaerentibus loculis 2 abortivis; coccus evolutus globosus, pro genere maximus, corticosus, glaber, fissuris irregulariter areolatus, intus pilis setaceis singulis adspersus; seminis testa crustacea, brunnea, splendens.

Arbor 7—10 m alta. Folia petiolo ca. 10 cm longo adjecto 40 cm et ultra longa; foliola cum petiolulis 1—1, 5 cm longis ca. 20 cm longa, 9 cm lata. Paniculae 10 cm et ultra longae. Fructus coccus diametro 2, 5 cm et ultra, pericarpio 1, 5 mm crasso.

In archipelagi Sandwicensis insulis Oahu, Molokai et Maui: Hillebrand! ("Oahu, on the S. W. slope of Mount Kaala, left branch of Makaleha;" "Molokai, on the pali of Kalaupapa;" ca. 1870; Hb. Kew.; Berol.); J. F. Rock (Maui, in declivibus montis Haleakala meridiem versus, a. 1910, fl. et fr., ex ipso in litt. m. Jan. 1911; specimina non vidi). 22. II. ii. L. Radlkofer.

The above description was communicated to me by Prof. Dr. L. Radlkofer of Munich for publication. (J. F. Rock.)

Flowering specimens of *Alectryon macrococcus* which until now were unknown, were collected by me, together with young and mature fruits on the southern slope of Mt. Haleakala, Maui, on the lava field of Auahi at an elevation of 2,600 feet, where the tree is not uncommon (see Report of the Board of Agriculture and Forestry for the Biennial Period 1910, p. 81).

Following is a description of the flowers of *A. macrococcus* with additional notes on the fruits:

Inflorescentia paniculata, contracta, axillaris, pilis flavescentibus prorsus induta; flores parvi, in pedicellos 2 mm longos, conferti; calyx 5-lobus 2 mm longus, lobis subacutis, persistens in coccis junioribus; petala nulla; stamina 6-8, inter sinus disci parvi extus inserta, filamentis brevissimis, hirsutis; antherae rubrae, 1 mm longae, ad basin subdidymae; ovarium a lateribus compressum, dense strigosum, 1-2-cellulis; stylus brevis, fere arcuatus, stigmate 2-fido; fructus 1-2-cocci, juniores pilis fulvis setulosis appressis, cum residuis styli, maturi glabri, fuscati, globosi, 3-6 cm diametro, arillo coccineo, etc.

Inflorescence an axillary contracted panicle, covered throughout with yellowish hairs; flowers small, on pedicells of 2 mm, densely clustered; calyx persistent with the young fruits, 5-lobed 2 mm long, the lobes subacute; petals none; stamens 6-8 inserted externally between the sinuses of the small disc, on very short hirsute filaments, anthers red, 1 mm long, subdidymous at the base; ovary compressed, densely strigose, 1-2 celled; style short almost arcuate, stigma two lobed; fruit consisting of 1-2-cocci, the young ones covered with appressed setulose, yellowish hairs, crowned by the remnants of the style, mature ones glabrous, dark brown, globose, 3-6 cm in diameter. Arillus scarlet, edible, etc.

Flowering and fruiting specimens (No. 8642) collected November 10-20, 1910. The wood is yellowish brown, hard grained and exceedingly tough. The flowers appear to be polygamous, as stamina are present in female flowers.

July 8, 1911, J. F. Rock. Board of Commissioners of Agriculture and Forestry, T. H.

Plate 1. **Alectryon macrococcus** Radlk.

Mahoe. Showing young and mature fruits and seed. Slightly less than one-third natural size.

Sapindus Thurstonii, Rock sp. n.

Vulgo A'e et Manele in Hawaii.

Arbor (decidua?) 10 m—26 m alta, truncus erectus 0.3 m—1.3 m diameter; cortice bruneo, desquamante ab arboribus maturis; rami teretes brunei, glabrati; folia alterna abrupte vel impari-pinnata, petiolis 4.5 cm—6 cm longis, tomentulosis, rachibus minime marginatis et in folia novella alatis; foliolis suboppositis, minime falcatis, 6 cm—12 cm longis, 2 cm—3.5 cm latis, apice acuminatis, basi rotundis, supra glabris, subtus tomentulosis; nervo mediano valide prominente; paniculae terminales pubescentes circa 12 cm longae; flores—(ignoti); cocci 1—2 globosi 17 mm—20 mm diametro, ad basin connati vel singuli cum rudimentis 1—2 ovulorum abortivorum; pericarpium coriaceum; semina globosa, fuscata vel nigra 10 mm—12 mm diametro; testa ossea sine caespitosa pilositate ad basin.

In archipelagi Hawaiiensis insula Hawaii: J. F. Rock leg. in declivibus montis Hualalai, Puuwaawaa 2700 pedes s.m.Jun. a. 1909 et Mauna Loa orientem versus, 4500 pedes s.m. Aprilis a. 1911.

A. deciduous? tree 10 m-26 m high with a trunk of 0.3 m-1.3 m in diam.; bark light brown falling off in scales from old trees, exposing the smooth inner layers; branchlets terete, light brown and glabrous; leaves alternate abruptly or impari pinnate on a main petiole of 4.5 cm-6 cm, slightly tomentose, the rachis slightly marginate, but winged in the young leaves; leaflets nearly opposite and subsessile in 4-6 pairs, chartaceous elliptical—oblong slightly falcate, 6 cm-12 cm x 2 cm-3.5 cm, acuminate at the apex but rounded at the base, glabrous, dark green and somewhat shining above, light green and slightly tomentose underneath with the median nerve very prominent; the pubescent panicles are terminal, about 12 cm long, and branching; flowers unknown; ripe fruits consisting of 1-2 globose cocci 17 mm-20 mm in diam., which are connate at the base, or when single bear the rudiments of two abortive ones; pericarp coriaceous, endocarp pergameneous pale; seeds globose dark reddish brown or black 10 mm-12 mm in diam. with a bony testa bearing no tufts of hair at their base.

The tree is named in honor of Mr. L. A. Thurston of Hono-

Plate 2. **Sapindus Thurstonii** Rock.
A'e and Manele. Showing foliage, fruits and seeds.
About one half natural size.

lulu, who called my attention to its presence on Mauna Loa. The type material (No 8772) was collected when in company with Mr. W. M. Giffard on the eastern slopes of Mauna Loa, at an elevation of 4500 feet, in April, 1911. It is a remarkable tree attaining a height of about 80 ft. with trunks of more than four feet in diameter; it is plentiful in Kipuka Ki and Puaulu on the land of Keauhou about 6-8 miles from the Kilauea Volcano where it grows in company with *Pelea, Ochrosia, Straussia, Zanthoxylum,* etc. One would not suspect to find such trees in that locality as one travels for miles through Ohia (*Metrosideros polymorpha*) forest until all at once one strikes a grove of this remarkable tree which is called A'e by the natives on Mauna Loa, and Manele on Hualalai, North Kona. Unquestionably this tree must have extended farther down the mountain where the Ohia now grows, but was undoubtedly destroyed by the a-a (rough) lava flows from the flanks of the mountain. The few hundred acres on which this tree is found escaped the firy stream by their elevation, as no lava is visible, the soil being black and rich. The tree seems to be deciduous, as I have observed specimens with the leaves all yellow and dropping, while others had young leaves only, but I have not met with any having the branches entirely bare.

On a subsequent visit (July-August, 1911,) specimens with flower-buds were collected but being badly attacked by a species of caterpillar it was impossible to make out the structure of the flowers.

The writer waited several weeks for the flowers to unfold, but instead the whole inflorescenses began to wilt on every tree examined, due to the work of the caterpillar.

Hibiscadelphus Rock gen. nov.

Bracteolae 5-7, angustissimae lineares, liberae; calyx profunde et inaequaliter 2-3-fidus; columna staminea infra apicem 5-dentatum antherifera; ovarium 5-loculare, loculis 1-3 ovulatis; styli rami 5, suberecti, apice in stigmata capitata dilatati; capsula lignea loculide 5-valvis, endocarpio chartaceo solubili; semina reniformia, tomento albescenti-cano induta. Arbores mediocres cum tomento stellato; folia cordata, inaequaliter crenata; flores soli-

Plate 3. **Sapindus Thurstonii** Rock.
In forest on Mauna Loa, Hawaii.

tarii vel plures ex axillis foliorum; colore rubido obscuro vel luteo; calyx deciduus in fructibus maturis.

This proposed new genus consisting of 3 species peculiar to the dry sections of Hawaii and Maui, is nearest to Hibiscus from which it differs in its quite different flowers, deciduous calyx and woody capsule. All three species are exceedingly rare, only solitary trees being found in the various type localities, with exception of *Hibiscadelphus Hualalaiensis* of which several trees were found at Puuwaawaa and Waihou forest, on the western slope of Mt. Hualalai.

Hibiscadelphus Giffardianus Rock sp. n.

Arbor 7 m alta, truncus 0.3 m diam. cortice albineo glabrato, ramis robustis teretis; foliis longe petiolatis, orbiculatis rustice acuminatis basi cordatis, tomento stellato utrinque indutis; palmato —septemnervatis, cum glandibus hispidis in angulis nervorum; stipulis parvis, triangulatis caducis; floribus solitariis vel pluribus, bracteolis 5-7 linearibus liberis; calyce saccato profunde et inaequaliter 2-3-fido, lobis acuminatis, extus pilis stellatis induto, intus glabro; corolla convoluta inflexa dependente in pedicellis 2 cm-3 cm longis; petalis erectis obliquis oblongis, apice acutis 5 cm-6 cm longis, partibus petalorum expositis pilis stellatis dense punctulatis; columna staminea petalis longiore, ad basin hispida, tubo costato tractu longo filamentis longis affixis; ovario glabro; stigmatibus capitatis; capsula lignea 4 cm-5 cm x 2 cm-2.5 cm, pro genere maxima, oblonga, rugosa extus pilis stellatis luteis induta; endocarpio chartaceo splendente tomentuloso, seminibus magnis lanatis.

In archipelagi Hawaiiensis insula Hawaii: J. F. Rock leg. in declivibus montis Mauna Loa orientem versus 4300 pedes s. m. fr. et fl. Aprilis et Jun. a. 1911.

A tree 7 m high with a trunk of 0.3 m in diam., bark smooth fibrous, whitish, branches terete, glabrous covered with leaf scars; leaves on long petioles orbicular—cordate bluntly acute at the apex 12-15 cm each way, unevenly crenate, papery, covered on both sides with a stellate tomentum, palmately 7-nerved, with hispid glands in the angles of ribs and veins on both sides; stipules small, triangular caducous; flowers solitary or several on the axils of the leaves on the ends of the branches; bracteoles 5-7,

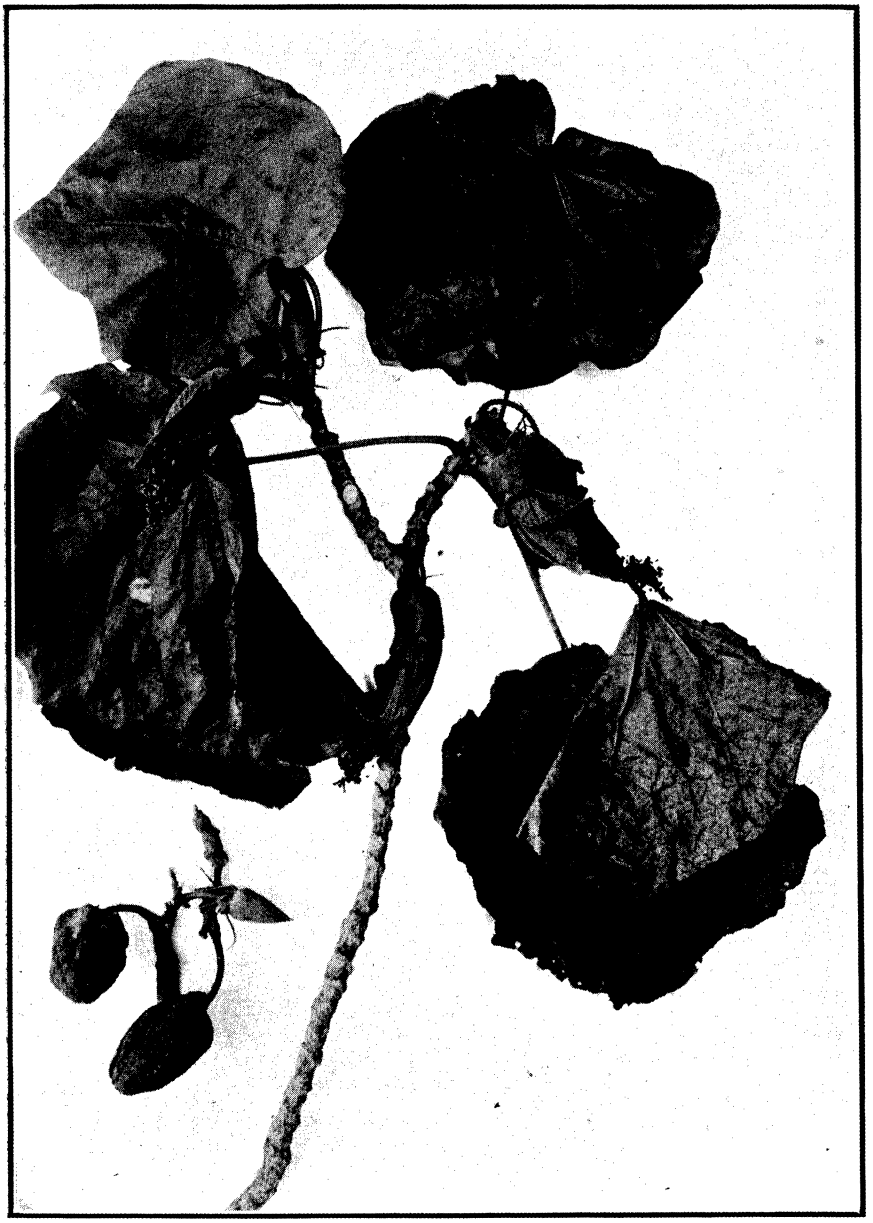

Plate 4. **Hibiscadelphus Giffardianus** Rock
Hau Kuahiwi. Showing open flowers and mature fruits.
About one half natural size.

very narrow, 2 cm long, free; calyx saccate, as long as the bracteoles, deeply and unevenly 2-3 cleft, lobes acuminate, many nerved, yellowish-green outside, with stellate hairs, glabrous inside; corolla convolute, curved, only the very apex slightly opening, not spreading as in Hibiscus, dependent on pedicells of 2-3 cm, petals erect 5-6 cm long, acute at the apex, oblique, oblong, deep magenta inside, grey with a stellate hispid tomentum on the exposed parts, especially on the prominent nerves; staminal column one-third longer than the petals, with numerous long filaments on nearly half its length, hispid at the base; style branches sub-erect 5 mm hispid; stigmas flesh-colored; capsule woody oblong 4-5 cm x 2-2.5 cm broadest at the base tapering towards the apex, rugose covered with stellate hispid hairs; the calyx and bracteoles deciduous in mature fruits, endocarp chartaceous shining glabrous; seeds large 7-10 mm reniform covered with a whitish grey wool.

The type material (No. 8773 Herbar. Board of Agriculture and Forestry, T. H.) was collected in April, 1911, in company with Mr. W. M. Giffard of Honolulu, who was the first to introduce many beautiful varieties of Hibiscus into the Territory and in whose honor the plant is named. Only one tree was found on the eastern slope of Mauna Loa at Puaulu on the land of Keauhou a few miles from Kilauea Volcano, at an elevation of 4300 feet, within the area of the proposed National Park.

Hibiscadelphus Wilderianus Rock sp. n.

Arbor 5 m, trunco erecto; foliis orbiculatis vel trilobatis cordatis, apice acutis, in petiolis stramineis 7-10 cm longis, palmato-quinque- rarius septemnervatis, supra puberulis subtus pilis minutis stellatis inspersis, nervis prominentibus hispidis; stipulis parvis subulatis puberulis; floribus solitariis in pedicellis 4 cm longis; bracteolis linearis 2 cm longis, uninerviatis liberis; calyce saccato inaequilatero trilobato, extus hirsuto intus puberulo, lobis acuminatis; (flores aperti ignoti). Petalis luteis in gemma; capsula ovoidea 3.5 cm x 3 cm, nigranta tuberculata, stellato-hispida lignosa.

In insula Maui: J. F. Rock leg. in declivibus montis Haleakala meridiem versus Nov. a. 1910.

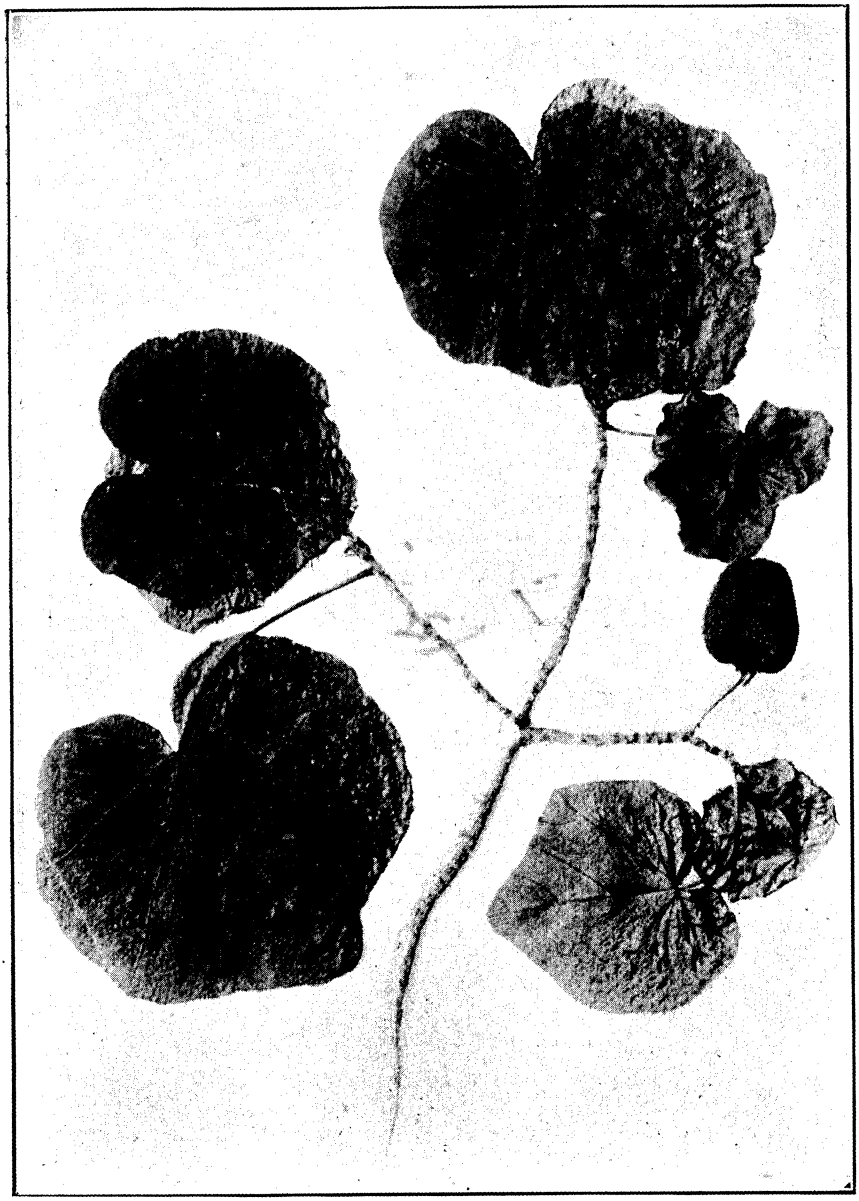

Plate 5. **Hibiscadelphus Wilderianus** Rock.
Showing foliage and fruit. About one half natural size.

Only one tree was observed on the southern slope of Haleakala on the lava fields of Auahi at an elevation of 2600 feet. (Type No. 8663 Herb. Board of Agriculture and Forestry, T. H.). Named in honor of Mr. Gerrit P. Wilder of Honolulu who has shown great interest in growing and producing many varieties of Hibiscus.

Hibiscadelphus Hualalaiensis Rock sp. n.

Arbor 5-7 m alta, trunco erecto, 0.3 m diam. cortice albineo, glabrato; rami teretes, cum foliis novellis dense hirsuti, foliis reniformi-cordatis in petiolis 10 cm-16 cm longis, supra pilis stellatis inspersis, subtus tomentosis; (flores ignoti) capsula parva ovata 2 cm x 1.5 cm pilis stellatis flavescentibus dense induta.

In insula Hawaii: J. F. Rock leg. in declivibus montis Hualalai occidentum versus Jun. a. 1909.

Type material (No. 3915 Herbar. Board of Agriculture and Forestry, T. H.) collected June 18, 1909, at an elevation of 2700 feet on the lava fields of Puuwaawaa and in the forest of Waihou where a number of trees is to be found. The flowers are said to be yellow.

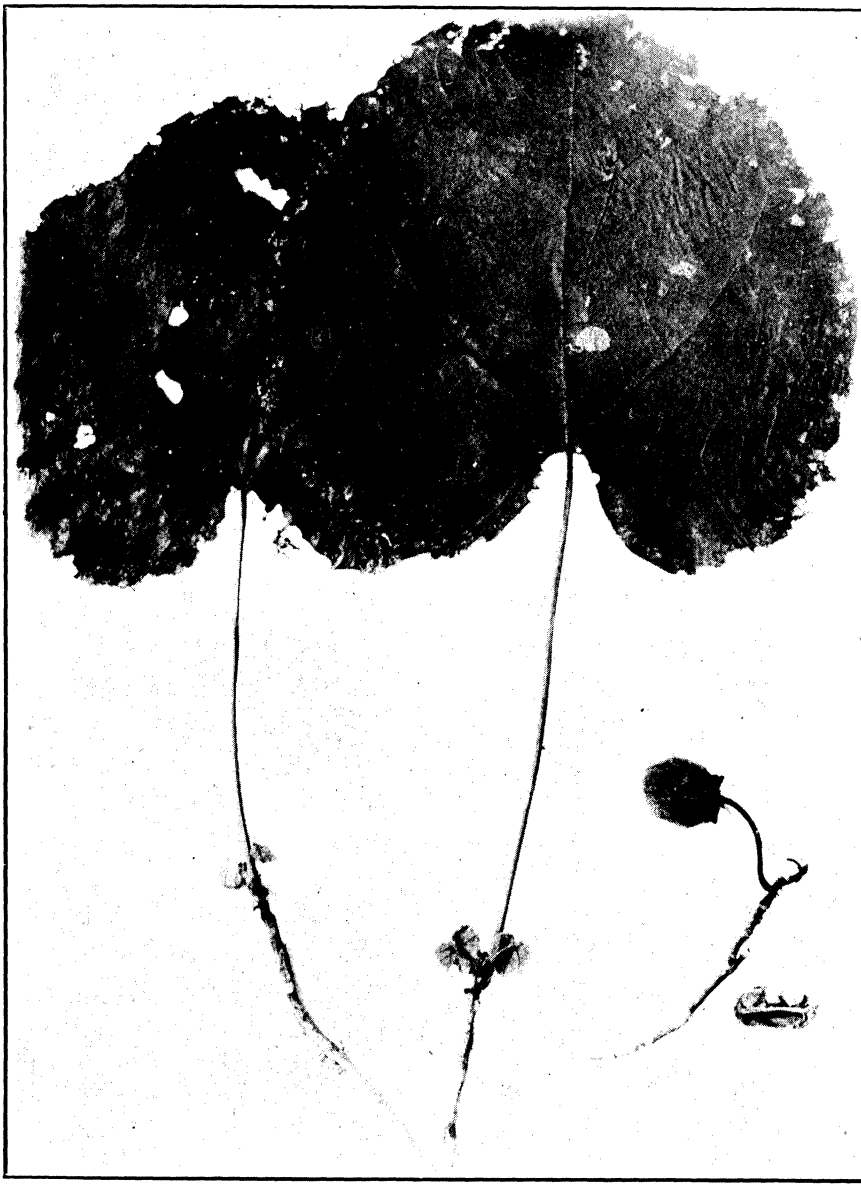

Plate 6. **Hibiscadelphus Hualalaiensis** Rock.
Showing foliage, mature fruits and seeds. About one half natural size.

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BOTANICAL BULLETIN NO. 2 JUNE, 1913

TERRITORY OF HAWAII

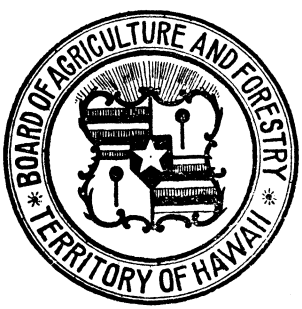
BOARD OF AGRICULTURE AND FORESTRY

List of Hawaiian Names of Plants

BY

JOSEPH F. ROCK

Consulting Botanist, Board of Agriculture and Forestry



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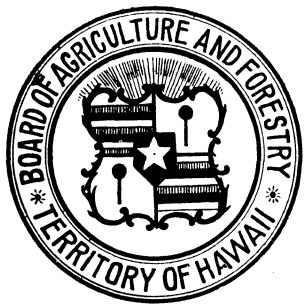

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ALPHABETICAL LIST OF HAWAIIAN NAMES OF PLANTS.

The following list of Hawaiian plant-names has been compiled from various sources. Hillebrand in his valuable Flora of the Hawaiian Islands has given many Hawaiian names, especially of the more common species; these are incorporated in this list with a few corrections. Nearly all Hawaiian plant-names found in this list and not in Hillebrand's Flora were secured from Mr. Francis Gay of the Island of Kauai, an old resident in this Territory and well acquainted with its plants from a layman's standpoint. It was the writer's privilege to camp with Mr. Gay in the mountains of Kauai collecting botanical material; for almost every species he could give the native name, which he had secured in the early days from old and reliable natives. Mr. Gay had made spatter prints of many of the native plants in a large record book with their names and uses, as well as their symbolic meaning when occurring in *mele* (songs) or *olioli* (chants), attached to them.

For all this information the writer is indebted mainly to Mr. Francis Gay and also to Mr. Augustus F. Knudsen of the same Island. The writer also secured Hawaiian names from old natives and *Kahunas* (priests) in the various islands of the group.

It is sad to relate that this interesting knowledge is fast disappearing; only the very old people are able to give reliable information, while the middle-aged class perhaps has heard of the various Hawaiian plant-names but cannot associate them with the particular plants. With few exceptions the young generation of Hawaiians knows nothing of folk lore and less of plants and the uses for which their ancestors valued them.

The names of plants vary on the different islands, and so it happens that a particular species might be known by three or four names. There is a close resemblance of Hawaiian names of plants and Tahitian and New Zealand plant names of related species; as for example the Hawaiian Ie ie (*Freycinctia Arnotti*) and the New Zealand *Kie kie* (*Freycinctia Banksi*) of the same genus; numerous instances of this sort may be cited. The scientific names are according to Engler and Prantl's Natürliche Pflanzenfamilien and the laws of nomenclature as set forth in the Botanical Congress of Vienna (1905).

LIST OF PLANTS—MAINLY TREES AND SHRUBS.

AAKA—Dead trunks of *Myoporum sandwicense.*
AALII KUMAKANI—*Dodonaea viscosa.*
AALII KUMAKUA—*Dodonaea eriocarpa.*
AALII MAHU—*Styphelia tameiameia.*
AAWA HUA KUKUI—*Pittosporum hosmeri.*
AE—*Polypodium pellucidum.*
A'E—*Xanthoxylum kauaiense.*
AE LAUNUI—*Asplenium* sp?
AEAE—*Lycium sandwicense.*
AHAKEA—*Bobea* spp.
AHAKEA LAU LII—*Bobea elatior,* var.*brevipes.*
AHAKEA LAUNUI—*Bobea elatior.*
AHANIU—*Cladium Meyenii.*
AHINAHINA—*Argyroxiphium sandwicense.*
AIAI—*Pseudomorus Brunoniana.*
AIEA—*Nothocestrum* spp.
AIEA—*Ilex sandwicensis,* only on Kauai.
AKAAKAAWA—*Hillebrandia sandwicensis.*
AKALA—*Rubus hawaiiensis* and *R. Macraei.*
AKEA—See AKIA.
AKIA—*Wikstroemia* spp.
AKILOLO—A variety of Sugar Cane.
AKIOHALA—*Hibiscus youngianus.*
AKOKO—*Euphorbia lorifolia.* Hawaiian Rubber.
AKOKO—Other species of *Euphorbia.*
AKOLE—*Dryopteris unidentata.*
AKOLEA—*Bochmeria stipularis.*
AKU—*Cyanea tritomantha.*
AKULIKULI—*Sesuvium portulacastrum.*
AKULIKULI LAULII—*Portulacca oleracea.*
AKUPA—*Bobea Mannii.*
ALAA—*Sideroxylon* spp.
ALAALA—Tubers of *Dioscorea sativa.*
ALAALA HUA—See MAHOE.
ALAALAPULOA—*Waltheria americana.*
ALAALAWAINUI—*Peperomia* spp.
ALAE—*Asplenium horridum.*
ALAHEE—*Plectronia odorata.*
ALANI—*Citrus aurantium.*
ALANI—*Pelea* spp.
ALANIWAI—*Pelea Waialealae.*
ALAWEO—*Chenopodium sandwicheum.*
ALE—*Plantago princeps.*
ALENA—*Boerhaavia diffusa.*

ALIIPOE—*Canna indica.*
ALULA—*Brighamia insignis.*
AMAU—*Sadleria pallida.*
AMA'UMA'U—*Sadleria cyatheoides.*
ANAPANAPA—*Colubrina asiatica.*
ANAUNAU—*Lepidium serra.*
ANINI—*Eurya sandwicensis.*
ANONIA—See ALANIWAI.
ANOUNOU—*Lepidium owahiense.*
ANUNU—*Sicyos* spp.
APE—*Alocasia macrorrhiza.*
APEAPE—*Gunnera petaloidea.*
APII—See APE.
APUU—*Sadleria squarrosa.*
AU—*Kadua acuminata.*
AUHOLA—*Tephrosia piscatoria.*
AUHUHU—See AUHOLA.
AULU—*Sapindus oahuensis;* see LONOMEA.
AULU—*Pisonia sandwicensis.*
AUPAKA—*Isodendrion pyrifolium.*
AWA—*Piper methysticum.*
AWAKANALOA—*Ranunculus mauiensis.*
AWAPUHI—*Zingiber zerumbet.*
AWAPUHIAKANALOA—*Liparis hawaiiensis.*
AWEOWEO—See ALAWEO.
AWIKIWIKI—*Canavalia galeata.*
AWIWI—*Kadua Cookiana.*
AWIWI—*Erythraea sabaeoides.*

EHUAWA—*Cyperus laevigata.*
EKAHA—*Asplenium nidus.*
EKAHA AKOLEA—*Polypodium lineare.*
EKAHA ULA—*Elaphoglossum micradenium.*
EMOLOA—*Eragrostis variabilis.*
ENAENAE—*Gnaphalium luteo-album.*
ENUHE—See ULUHE.

HAA—*Antidesma platyphyllum.*
HAHA—*Cyanea* and *Clermontia* spp.
HAHAAIAKAMANU—*Clermontia gaudichaudii.*
HAHALUA—*Cyanea leptostegia.*
HAHANUI—*Cyanea ferox.*
HAILIOPUA—*Schizaea robusta.*
HAIWALE—*Cyrtandra gayana.*
HALAPEPE—*Dracaena aurea.*
HALEAKAIA—*Cardiospermum Halicacabum.*

HAME or HAA—*Antidesma pulvinatum.*
HAO—*Rauwolfia sandwicensis.*
HAU—*Hisbiscus tiliaceus.*
HAUHELE ULA—*Kokia drynarioides* on Kauai.
HAUHELE WAI—See AKIOHALA.
HAUOI—*Stachytarpheta dichotoma.*
HAWANE—*Pritchardia* spp.; and also seeds of same.
HEAE—See AE (*Xanthoxylum*).
HEAU—*Exocarpus sandwicensis.*
HEII—*Cibotium Menziesii.*
HIALOA—*Waltheria americana.*
HINAHINA—*Heliotropium anomalum.*
HOAWA—*Pittosporum* spp.
HOAWA LAUNUI—*Pittosporum kauaiense.*
HOE A MAUI—*Elaphoglossum micradenium.*
HOI—*Dioscorea sativa,* see ALAALA.
HOI—*Verbena bonariensis.*
HOIO—*Diplazium Arnottii.*
HOLA—See AUHUHU.
HOLEI—*Ochrosia sandwicensis.*
HOLIO—*Cryptocaria Mannii.*
HONA'—*Arera sandwicensis* var. *kauaiensis.*
HONOHINO—*Cleome sandwicensis.*
HONOHONO—*Haplostachys Grayana.*
HONOHONO—See HONOHONOWAI.
HONOHONOWAI—*Commelina nudiflora.*
HONUAULU—A variety of Sugar Cane.
HOWAIAULU—*Lagenophora mauiensis.*
HUAHUAKO—*Rumex albescens.*
HUAKEKILI—*Scaevola frutescens.*
HUEHUE—*Cocculus ferrandianus.*
HUEIE—See HUEHUE.
HUEWAI—*Lagenaria vulgaris;* (Bottle gourd).
HULUHULU—*Gossypium tomentosum.*
HULUHULUAIOLE—*Lycopodium cernuum.*
HULUMOA—*Exocarpus sandwicensis.*
HULUMOA—*Viscum articulatum.*
HUNAKAI—*Ipomoea acetosaefolia.*

IEIE—*Freycinetia Arnotti.*
IHI—*Portulaca oleracea.*
IHIMAKOLE—*Portulaca sclerocarpa.*
IIWA LAULII—*Asplenium erectum.*
ILIAHI—*Santalum* spp; Sandalwood.
ILIAHI—*Santalum Freycinetianum;* Sandalwood.
ILIAHI ALOE—*Santalum Freycinetianum* var. *littorale.*

ILIAU—*Wilkesia gymnoxiphium.*
ILIEO—*Plumbago zeylanica.*
ILIHIA—*Cyrtandra begoniaefolia.*
ILIMA—*Sida* spp.
ILIOHA—*Erigeron canadense.*
ILIOHE—See ILIOHA.
ILIOHU—*Cleome sandwicensis.*
INALUA—See HALEAKAIA.
INIA—*Melia Azedarach.* Pride of India.
INIKA—*Basella rubra.*
INIKOA—*Indigifero anil.*
IO NUI—*Aspidium filix-mas.*
IPU—*Lagenaria vulgaris.*
IPU NUI—*Cucurbita maxima.*
IWA—*Pteris excelsa.*
IWAIWA—*Asplenium adiantum-nigrum.*
IWAIWA—*Doryopteris decipiens.*
IWAIWA—*Adiantum capillus-veneris.*
IWAIWA LAUNUI—*Aspidium cicutarium* var. *Gaudichaudii.* . .
IWAIWA O KANE—*Asplenium bipinnatifidum.*
IWAPUAKEA—*Pteris irregularis.*

KAAPEAPE—*Polystichum falcatum* var.
KAAWAU—*Ilex sandwicensis;* AIEA on Kauai.
KAEEE—*Mucuna gigantea.*
KAIWI—See NUKUIWI.
KAKALAIOA—*Caesalpinia bonducella.*
KAKONAKONA—*Panicum torridum.*
KAKONAKONA—*Panicum nephelophilum* var. *xerophilum.*
KALAIPAHOA—A Kahuna tree, extinct; (perhaps only mythical).
KALAMALO—*Eragrostis variabilis.*
KALAMOHO LAULII—*Pellaea ternifolia.*
KALAMONA—*Cassia laevigata.*
KALEIOHIIAKA—*Pelea elliptica* var.
KALIA—*Elaeocarpus bifidus.*
KALILI—*Viola Kauaiensis;* see POHE HIWA.
KALO—See TARO.
KALUAHA—*Astelia Menziesii.*
KALUHA—*Cyperus strigosus* var. *insularis.*
KAMANAMANA—*Adenostema viscosum.*
KAMANI or KAMANU—*Calophyllum Inophyllum.*
KAMANI—*Terminalia catappa.*
KAMANOMANO—*Cenchrus calyculatus.*
KAMAKAHALA—*Labordia* spp.
KAMAKAHALA LAULII—*Labordia Waialealae.*

KAMANU—See KAMANI.
KAMOLE—See PUKAMOLE.
KAMOLE—*Polygonum glabrum.*
KANAWAU—*Broussaisa arguta* and *B. pellucida.*
KANEHOA—See PUKEAWE.
KAPANA—*Phyllostegia grandiflora.*
KAUILA—*Colubrina oppositifolia.*
KAUILA—*Alphitonia excelsa.*
KAUILA MAHU—*Cheirodendron Gaudichaudii.*
KAULU—*Pteralyxia macrocarpa.*
KAULU—*Sapindus oahuensis* (on Oahu).
KAULU—*Pisonia sandwicensis* (on Kauai).
KAULU—*Sideroxylon sandwicense;* see ALAA.
KAUMAHANA—*Viscum articulatum.*
KAUMAHANA—*Exocarpus sandwicensis.*
KAUNOA—*Cassitha filiformis.*
KAUPOO—See PAUOHIIAKA.
KAUPU—*Polystichum aculeatum.*
KAWAU—*Ilex sandwicensis.*
KAWAU—*Styphelia tameiameia* (on Lanai).
KAWAU KUA KUKU KAPA—*Xanthoxylum dipetalum* var. γ.
KAWELU—*Schiedea stellarioides;* see MAOLIOLI.
KEA—*Mezoneurum kauaiense* on Maui; see UHIUHI.
KEAHI—*Chrysophyllum polynesicum.*
KENIKENI—See KO. Sugar cane.
KI—*Cordyline terminalis.*
KIHE—*Polypodium serrulatum.*
KIKANIA—*Xanthium strumarium.*
KIKANIA PILIPILI—*Desmodium uncinatum.*
KIKAWAEO—*Dryopteris cyatheoides.*
KILAU—*Dryopteris glabra.*
KALAU—*Trichomanes davallioides.*
KILAUAPUEO—*Pteridium aquilinum.*
KILIKA—*Morus nigra.*
KILIOOPU—*Cyperus auriculatus.*
KIOELE—*Kadua Menziesiana.*
KIPONAPONA—*Phyllostegia racemosa.*
KO—*Saccharum officinarum* . Sugar cane.
KOA—*Acacia Koa.*
KOAHAOLE—*Leucaena glauca.*
KOAIA—*Acacia Koaia.*
KOAKA—See KOA.
KOALI AI—*Ipomoea tuberculata.*
KOALI AWAHIA—*Ipomoea insularis.*
KOALI MAHU—*Ipomoea dissecta?*
KOAOHA—See KOAIA.

KOHEKOHE—*Heleocharis obtusa.*
KOHOLAPEHU—*Raillardia latifolia.*
KOI—*Coprosma stephanocarpa* var. *Kauaiensis.*
KOKEA—See KO. Sugar cane.
KOKIO—*Kokia Rockii* and *K. drynarioides.*
KOKIO KEOKEO—*Hibiscus Arnottianus.*
KOKIO ULA—*Hibiscus Kokio.*
KOKO—*Euphorbia* spp.
KOKOKAHIKO—*Euphorbia pilulifera.*
KOLEA—*Suttonia* spp.
KOLEA LAULII—*Suttonia sandwicensis.*
KOLI—*Ricinus communis.*
KOLII—*Lobelia macrostachys.*
KOLOKOLO—See MAHINALUA.
KOLOKOLO KAHAKAI—*Vitex trifolia.*
KOLOKOLO KUAHIWI—*Lysimachia daphnoides.*
KOLOKOLO LEHUA—See KOLOKOLO KUAHIWI.
KOLOKOLO MOKIHANA—*Pelea* sp?
KONAKONA—*Panicum nephelophilum.*
KOOKOLAU—*Campylotheca* spp.
KOOKOOLAU—See KOOKOLAU.
KOPA—*Kadua glaucifolia.*
KOPIKO KEA—*Straussia Kaduana.*
KOPIKO ULA—*Straussia* spp.
KOU—*Cordia subcordata.*
KUAHULU—*Ipomoea pentaphylla.*
KUAU—*Asplenium Kaulfussii.*
KUAWA—*Psidium guayava.*
KUAWAWAENOHU—*Schiedea lychnoides.*
KUHIAIKAMOOWAHIE—*Lobelia hypoleuca.*
KUKAIMOA—*Pelea microcarpa.*
KUKAINENE—*Coprosma ernodeoides.*
KUKAIPUAA—*Panicum pruriens.*
KUKUI—*Aleurites moluccana.*
KUKUIHI—*Jatropha curcas.*
KUKUKU—*Colubrina asiatica.*
KULUI—*Nototrichium* spp.
KUMUNIU—*Doryopteris decipiens;* see IWAIWA and MANAWAHUA.
KUOLOHIA—*Rhynchospora laxa;* see PUUKOA.
KUPALA—*Sicyos pachycarpus.*
KUPAUA—*Raillardia scabra.*

LAAUALA—The wood of *Santalum Freycinetianum.*
LAHI—See KO. Sugar cane.
LAKI—Names of the leaves of *Cordyline terminalis.*

LAMA—*Maba sandwicensis.*
LANIWELA—*Erigeron canadense.*
LAPALAPA—*Cheirodendron platyphyllum.*
LAUALA—See LAUHALA or PUHALA.
LAUHALA—*Pandanus odoratissimus.*
LAUKAHI—*Dryopteris truncatum.*
LAUKAHI—*Dryopteris filix-mas.*
LAUKAHI—*Lindsaya repens.*
LAUKAHI—*Elaphoglossum wawrae.*
LAUKAHI—*Ophioglossum pendulum.*
LAUKAHI—*Ophioglossum vulgatum.*
LAUKAHI—*Pellaea ternifolia.*
LAUKEA—*Claoxylon tomentosum.*
LAUKONA—A variety of Sugar cane (ribbon cane).
LEHUA AHIHI—*Metrosideros tremuloides.*
LEHUA KAMAKUA—*Metrosideros polymorpha* with sessile leaves.
LEHUA LAULII—*Metrosideros polymorpha.*
LEHUA MAKANOE—*Metrosideros pumila.*
LEHUA MAMO—*Metrosideros polymorpha;* yellow flowered..
LEHUA PAPA—*Metrosideros rugosa.*
LEHUA PUAKEA—*Metrosideros polymorpha.*
LEPELEPEAMOA—*Selaginella arbusculla.*
LILILEHUA—*Salvia coccinea.*
LILIWAI—*Acaena exigua;* see NANIWAIALEALE.
LILIKOI—*Passiflora edulis.*
LIUA—*Lobelia hypoleuca.*
LOLA—*Asplenium acuminatum.*
LONOMEA—*Sapindus Oahuensis.*
LOULU—*Pritchardia* spp.
LOULU HIWA—*Pritchardia Gaudichaudii.*
LOULU LELO—*Pritchardia Hillebrandii.*

MAHINALUA—*Polypodium pseudogrammitis.*
MAHOE—*Alectryon macrococcus.*
MAHU—*Cheirodendron gaudichaudii;* see OLAPA.
MAIA—*Musa sapientum.* Banana; there are numerous varieties.
MAIAPILO—*Capparis sandwicheana.*
MAIELE—*Styphelia tameiameia.*
MAILE—*Alyxia olivaeformis.*
MAIRI—*Alyxia olivaeformis.*
MAKOLE—*Nertera depressa.*
MAKOU—*Ranunculus mauiensis.*
MAKOU—*Peucedanum sandwicense.*
MAKOU—*Botrychium subbifoliatum.*

MAKUE—*Elaphoglossum squamigerum.*
MAKUE LAULII—*Polypodium Hookeri.*
MAMAKE or MAMAKI—*Pipturus* spp.
MAMANI—*Sophora chrysophylla.*
MANA—*Pteris irregularis.*
MANAWAHUA—*Doryopteris decipiens.*
MANELE—*Sapindus saponaria.*
MANENA—*Pelea cinerea.*
MANENE—*Plantago pachyphylla* var. *Kauaiensis.*
MANIENIE—*Gynodon dactylon.*
MANIENIE—*Stenotaphrum americanum.*
MANONO—*Gouldia* spp.
MANULELE—See Ko. Sugar cane.
MANUNENE—*Kyllingia brevifolia.*
MAO—*Gossypium tomentosum.*
MAO—*Abutilon incanum.*
MAOHAUHELE—*Hibiscus Brackenridgei.*
MAOHIOHI—*Stenogyne rugosa.*
MAOLIOLI—*Schiedea stellarioides.*
MAOLOA—*Neraudia melastomaefolia.*
MAPELE—*Crytandra* sp.?
MAUA—*Xylosma Hawaiiense* and *X. Hillebrandii.*
MAUNALOA—*Dioclea violacea.*
MIKANA—*Carica papaya,* on Hawaii.
MIKINALO—*Drosera longifolia.*
MILO—*Thespesia populnea.*
MOHIHI—*Stenogyne scrophularioides.*
MOKIHANA—*Pelea anisata.*
MULO—See MILO.

NAENAE—Species of the genera *Dubautia* and *Raillardia.*
NAENAE PUAKEA—*Dubautia paleata.*
NAENAE PUAMELEMELE—*Dubautia laxa.*
NAENAE ULA—*Dubautia raillardioides.*
NAIEO—See NAIO.
NAIO—*Myoporum sandwicense.*
NAHELEHELE—*Ageratum conyzoides.*
NANEA—*Vigna lutea.* See PULIHILIHI.
NANIWAIALEALE—*Acaena exigua.* See LILIWAI.
NANU—*Gardenia Remyi.*
NAU—*Gardenia Brighami.*
NAU—See NANU.
NAUPAKA KAHAKAI—*Scaevola frutescens.*
NAUPAKA KUAHIWI—*Scaevola* spp.
NEHE—*Lipochaeta* spp.
NEKE—*Dryopteris gongylodes.*

NELEAU or NENELEAU—*Rhus semialata* var. *sandwicense.*
NIANIAU—*Nephrolepis exaltata.*
NINIKA—*Lithrum maritimum.*
NIOI—*Eugenia rariflora.*
NIU—*Cocos nucifera.* Coconut.
NOHU—*Tribulus cistoides.*
NOHUANU—*Geranium humile* var. *Kauaiense.*
NONI—*Morinda citrifolia.*
NUKUIWI—*Strongylodon lucidum.*
NUUMELA—*Asclepias curassavica.*
OALII MAKALII—*Schizaea robusta.*
OHA WAI—Species of *Clermontia.*
OHAI—*Sesbania tomentosa.*
OHAI KEOKEO—*Sesbania grandiflora.*
OHE—*Joinvillea adscendens.*
OHE—*Isachne distichophylla.*
OHE—*Bambusa vulgaris.* Bamboo.
OHE KIKOOLA—*Tetraplasandra Waimeae.*
OHE KUKULUAEO—*Reynoldsia sandwicensis.*
OHE MAKAI—See OHE KUKULUAEO.
OHELO—*Vaccinium* spp.
OHE WAI—Water containers made from Bamboo; see HUE-WAI.
OHELO KAI—*Lycium sandwicense.*
OHELO PAPA—*Fragaria chilensis.*
OHENAUPAKA—*Scaevola glabra.*
OHEOHE—*Pterotropia kauaiense* and *dipyrena.*
OHEOHE—*Vittaria elongata.*
OHIA—See OHIA AI.
OHIA AI—*Jambosa malaccensis.*
OHIA HA—*Syzygium sandwicense.*
OHIA LEHUA—*Metrosideros polymorpha.*
OHIAKU—*Hymenophyllum recurvum.*
OI—*Verbena bonariensis.*
OKUPUKUPU—*Doodia media.*
OLAPA—*Cheirodendron Gaudichaudii.*
OLENA—*Curcuma longa.*
OLENA—*Coprosma Waimeae.*
OLIANA—See KO, a variety of sugar cane.
OLOA—*Neraudia melastomaefolia.*
OLOHUA—*Solarum nodiflorum.*
OLOMEA—*Perrottetia sandwicensis.*
OLONA—*Touchardia latifolia.*
OLOPU—*Viola chamissoniana* var. *β.*
OLUA—*Dryopteris punctata.*
OPEHA—*Elaphoglossum gorgoneum* var. *β.*

OPUHE—*Urera sandwicensis.*
OPUHI—*Zingiber zerumbet.*
OWALII—*Asplenium trichomanes.*
OWALII—*Pteris cretica.*
PAI—*Polypodium hymenophylloides.*
PA-I-A—*Pteridium aquilinum.*
PAIHI—*Syzygium sandwicense,* on Maui.
PAINIU—*Astelia veratroides.*
PAKA—*Nicotiana tabacum* and *N. glauca.*
PAKAHA—*Sphacele hastata.*
PAKAHAKAHA—*Polypodium lineare.*
PALA—*Marattia Douglasii.*
PALAA—*Odontoglossum chinensis.*
PALAE—See UIUI.
PALAIHIHI—*Trichomanes davallioides.*
PALAIHINAHINA—*Hymenophyllum lanceolatum.*
PALAIHUNA—*Polypodium hymenophylloides.*
PALAILAAU—*Polypodium adenophorus.*
PALAILAULII—*Hymenophyllum obtusum.*
PALANI—See KO, a variety of sugar cane.
PALAPALAI—*Microlepia strigosa.*
PALAPALAI AUMAKUA—*Dryopteris crinalis.*
PALAPALAI LAULII—*Diellia pumila.*
PALAPALAI O KAUMAPUAA—*Dryopteris globulifera.*
PAMAKANI MAHU—*Phyllanthus sandwicensis.*
PAMAKANI—*Senecio sandwicensis.*
PAMAKANI—See PAMAKANI MAHU.
PAMAKANI—*Viola Chamissoniana,* on Molokai.
PAMOHO—*Asplenium resectum.*
PAMOHO—*Nephrolepis exaltata.*
PAMOHO—See OKUPUKUPU.
PANAUNAU—*Lobelia yuccoides.*
PANINI—*Opuntia tuna.* Cactus.
PANUNU KUAHIWI—*Sicyos cucumerinus.*
PAPAA—See KO, variety of sugar cane.
PAPAHEKILI—*Pittosporum acuminatum.*
PAPALA—*Charpentiera obovata.*
PAPALA—*Pisonia umbellifera.*
PAPALA KEPAU—*Pisonia inermis.*
PAPAOI—*Polystichum lobatum.*
PAPAPA—*Dolichos Lablab.*
PAPIPI—See PANINI.
PAUOHIIAKA—*Jacquemontia sandwicensis.*
PAUUOA—*Dryopteris squamigera.*
PAWALE—*Rumex giganteus.*
PEAHI—*Polypodium spectrum.*

PIA—*Tacca pinnatifida.*
PIIA—*Dioscorea pentaphylla.*
PIIPII—*Chrysopogon aciculatus.*
PIIPIILAUMANAMANA—*Asplenium pseudofalcatum..*
PILI—*Andropogon contortus.*
PILIKAI—*Argyreia tiliaefolia.*
PILO—*Coprosma* spp.
PILO—*Kadua laxiflora?*
PILO KEA—*Platydesma campanulatum.*
PILO ULA—*Pelea kauaiensis.*
PILOKEA LAULII—*Platydesma rostratum.*
PIOI—*Smilax sandwicensis,* Kauai.
PIPI—*Psilotum triquetrum.*
PIPIWAI—See KOHEKOHE.
POE—*Portulaca sclerocarpa.*
POHA—*Physalis peruviana.*
POHE HIWA—*Viola kauaiensis.*
POHEPOHE—*Hydrocotyle verticillata.*
POHINAHINA—*Heliotropium anomalum.*
POHOLE—*Diplazium Arnottii* var.
POHUEHUE—*Ipomoea pes-caprae.*
POLINALINA—*Vitex trifolia.*
POLOLEI—*Ophioglossum concinnum.*
POLOLO—*Cuscuta sandwichiana.*
POOLA—*Claoxylon sandwicense.*
POOLANUI—*Campylotheca cosmoides.*
PONIU—See INALUA.
POPOLO—*Phytolacca brachystachys.*
POPOLO—*Solanum aculeatissimum.*
POPOLO—*Solanum nodiflorum.*
POPOLO—*Cyanea solanacea.*
POPOLO AI A KE AKUA—*Solanum kauaiense.*
POPOLO KUMAI—*Solanum incompletum* var. *Mauiense.*
PUA—*Osmanthus sandwicensis.*
PUAAINAKA—*Stenogyne rotundifolia.*
PUAAKUHINIA—*Astelia menziesii.*
PUAALA—*Brighamia insignis.*
PUAHANUI—*Broussaisia arguta.*
PUAHEKILI—*Lysimachia Hillebrandii.*
PUAKALA—*Argemona mexicana.*
PUAKALA—*Cyanea solenocalyx.*
PUAKAUHI—*Canavalia galeata.*
PUAKEAWE—*Styphelia tameiameia.*
PUALELE—*Sonchus oleraceus.*
PUALOALO—*Hibiscus Kokio.*
PUAMAKANUI—*Hillebrandia sandwicensis.*

PUAMANA—*Erigeron canadense.*
PUANANAHONUA—*Solanum Carterianum.*
PUAOLE—A flowerless sugar cane.
PUAPILIPILI—*Desmodium uncinatum.*
PUAPILO—*Capparis sandwicheana.*
PUAPUAMOA—*Ophioglossum pendulum.*
PU'E—*Lobelia kauaiensis.*
PUHALA—*Pandanus odoratissimus.*
PUKAMOLE—*Jussiaea villosa.*
PUKEAWE—*Styphelia tameiameia.*
PULIHILIHI—*Vigna lutea.*
PUUKOA—*Rhynchospora laxa.*

TARO—*Coloccasia antiquorum.*
TI—*Cordyline terminalis.*
TO—See KO.
TOU—See KOU.
TUTUI—See KUKUI.

UALA—*Ipomoea batatas.* Sweet Potato.
UALA—A variety of Sugar cane.
UAHEAPELE—*Pelea barbigera.*
UHAOHAKO—*Rumex giganteus,* on Molokai.
UHI—*Smilax sandwicensis;* see ULEHIHI.
UHIUHI—*Mezoneurum kauaiense.*
UHIUHI—*Cassia Gaudichaudii.*
UIUI or PALAE—See NEKE.
UIWI—See AWIWI.
UKI—*Dianella odorata.*
ULAHIHI—See KUAHULU.
ULEHIHI—See UHI.
ULEI—*Osteomeles anthyllidifolia.*
ULIHI—*Phyllostegia* sp.
ULU and ULUKAKA—*Artocarpus incisa.* Bread fruit.
ULUHE—*Gleichenia linearis.* Staghorn Fern.
ULUHE LAUNUI—*Gleichenia longissima.*
ULUHI—See ULUHE.
ULUNAHELE—*Cyrtandra kauaiensis.*
ULUPUA—*Osmanthus sandwicensis.*
UMEALU—*Cenchrus echinatus.*
UMEKE POHUE—*Cucurbita maxima.*
UMEKE—After the gourd of *Cucurbita maxima* is cleaned.
UNUHI—See ULUHE.
UULEI—See ULEI.
UWIUWI—*Erigeron canadense.*

WAHANE—Seeds of *Pritchardia,* see HAWANE.
WAHINE NOHO MAUNA—*Polypodium tamariscinum.*
WAIAWI—*Psidium pomiferum.*
WAIMAKANUI—*Dryopteris Keraudreniana.*
WAIMEA—*Perrottetia sandwicensis,* Maui.
WAIMEA—*Pipturus ruber,* Kauai.
WALAHEE—*Plectronia odorata.*
WANINI—*Eurya sandwicensis.*
WAUKE—*Brousonetia papyrifera.*
WAWAE IOLE—*Lycopodium cernuum.*
WAWAE IOLE—*Lycopodium pachystachyon.*
WILIWILI—*Erythrina monosperma.*

LIST OF NATIVE NAMES OF INTRODUCED PLANTS.

INIA—*Melia Azedarach.* Pride of India.
KIAWE—*Prosopis juliflora.* Algaroba.
OHAI—*Pithecolobium Saman.* Monkey-pod..
OPIUMA—*Inga dulcis.*
WILIWILI—*Adenanthera pavonia* (on account of the red seeds resembling the native Wiliwili).
KLU—*Acacia farnesiana.*
LEMI WAI—*Passiflora laurifolia.* Water-lemon (yellow).
LILI WAI—See LEMI WAI.
LILI KOI—*Passiflora edulis.* Purple fruited water-lemon.
LAKANA—*Lantana camara.* Lantana.
KILIKA—*Morus nigra.* Mulberry.

LIST OF HAWAIIAN PLANT NAMES WHICH CAN NOT BE IDENTIFIED.

(Descriptions from original spatter work, made by Mr. F. Gay.)

PULIHILIHI—Evidently a trifoliate leguminous plant.

LAUKUA—A plant with an irregularly lobed leaf with broad sinuses between the lobes; grows on Kauai.

OLIKO—A small plant with linear lanceolate leaves; it may be *Suttonia lanceolata.*

KILIOE—A vine with small elliptical leaves at intednodes of 4.5 inches.

POKALAKALA—A plant with a 5-6 palmatisect leaf on petioles of 2 inches.

NAHUNAPALAI—A small fern, probably an *Aspidium.*

LIST OF NATIVE VARIETIES OF THE BANANA.

Musa sapientum.

HAA or IHOLENA HAA—Growing 6-8 feet high, leaf light green; stem light green with black streaks; scape short, but large, fruits pointed.

One of the choicest varieties for cooking.

PUAPUANUI, KAPUA, or PUUHALA—A banana similar to the HAA, but is very tall like the LELE; scape shorter and smaller than of the HAA. It is also called MAOLIILI-LAHILAHI.

LELE—A very tall banana, stem blacker than in the HAA; leaf of a reddish color underneath.

IHOLENA, LOHA, IHO-U—Stem tall like that of the LELE, but leaf like that of the HAA, and not reddish, except on the margin. Growing in Kahana Valley at the mouth of Kawaiiki, Kauai.

MAOLI, KAHIKI—A very tall dark green stemmed banana, bearing a long and large bunch of long and round fruits of a dark green color, which become orange yellow when ripe; has a very fine flavored fruit. This variety has several forms which are known as: MANAEULA or PONI, PUHI, KANALAU and KOAE.

PONI, O'A—Similar to the MAOLI, leaf stalk purple, stem reddish; the scape is shorter than that of the MAOLI and so is the fruit. Growing on Kauai, at Wainenene.

HUAIWAENA or MAIA HAPAI—A banana with very small scape.

MAIA HUANUI—A banana bearing from 2-4 bunches.

KOAE or AEAE'—A tall banana with white and green striped leaves; the fruit is also white striped.

POPOULU—Similar of growth to the HAA, fruits short, and round, ends flattened.

KANALUA—A banana like the MAOLI, stem is shorter and the fruits resemble those of the PONI.

MAIA HEI—Leaf dark striped, scape standing erect.

LIKO—A Tahitian banana.

MOA—Stem very tall, bunches small, having only three rows of fruits, skin rough.

Of foreign or introduced bananas the natives distinguish the following:

MAIA ANOANO—Manila banana.

MAIA PAKE—Chinese banana (*Musa Cavendeshi.*)

MAIA NUHOLANI—Brazilian banana.

OPULE or MAIA KOANA—Fruits are spotted; and produce seeds.

LIST OF HAWAIIAN ALGAE (SEAWEEDS) OR LIMU WITH THEIR NATIVE NAMES.*

LIMU AALAULA—*Codium Muelleri* Kütz.
" " — " *tomentosum* (Huds.) Stackh.
" AKAAKOA—*Ectocarpus* sp.
" AKIAKI—*Ahnfeldtia concinna* J. Agh.
" AKUILA—*Chylocladia* sp.
" ALANI—*Dictyota acutiloba distorta.*
" " — " *Dichotoma.*
" AUPUPU—*Griffithsia* sp.
" AWIKIWIKI—*Gymnogongrus disciplinalis* (Bory) J. Agh.
" EKAHAEKAHA—*Gymnogongrus vermicularis americana* J. Agh.
" EKAHAKAHA—*Gelidium filicinum.*
" ELEAU—See AKIAKI.
" ELEELE—*Enteromorpha flexuosa* (Wulf.) Agh.
" " — " *hopkirkii.*
" " — " *intestinalis* (L) Link.
" " — " *prolifera* (Muell.) J. Agh.
" HAULA—*Nitophyllum* sp.
" HAWANE—*Polysiphonia mollis.*
" " —*Strebdocladia* sp.
" HULU—*Centroceras clavulatum* (Agh.) Mont.
" HULUHULUWAENA—*Grateloupia filicina* (Wulf.) Agh.
" HULUILIO—See HULU.
" " —*Cladophora nitida* Kuetz.
" HULUPUAA—*Spiridia spinella.*
" HUNA—*Hypnea nidifica* J. Agh.
" HUNA—*Hypnea armata.*
" ILIO—*Chaetomorpha antennina* (Bory) Kuetz.
" KALA—*Sargassum echinocarpum* J. Agh.
" " — " *cymosum* J. Agh.
" " — " *polyphyllum* J. Agh.
" KALA-WAI—*Nais major* All.
" KALIPOA—*Griffithsia* sp.
" KAUPAU—*Chnoospora fastigiata pacifica* J. Agh.
" KIHE—*Chylocladia rigens?*
" KOELE—*Gymnogongrus* spp.
" KOELEELE—See KOELE.
" KOKO—See KOHU.
" KOHU—*Asparagopsis sanfordiana* Harv.

---

* The native names of the seaweeds were mostly compiled from a list by Miss Minnie Reed, an ardent student of the Hawaiian marine-flora.

LIMU KUWELA—*Gelidium* sp.
" LIPAAKAI—See KOHU.
" LEPEAHINA—*Halymenia formosa.*
" LIPEE—*Laurencia pinnatifida* (Gmel.) Lam.
" LIPAHAPAHA—*Ulva lactua rigida* (Agh.) Le Jolis.
" LIPAHEE—*Porphyra leucostica.*
" LIPALAHALAHA—*Ulva lactua laciniata* (Wulf.) J. Agh.
" LIPALAWAI—*Pithophora* sp.
" LIPEHU—See KOHU.
" LIPO—*Haliseris pardalis.*
" LIPOA—*Dictyota acutiloba distorta.*
" " —*Haliseris plagiogramma* Mont.
" LIPEPEIAO—*Amansia glomerata* Agh.
" LIPEEPEE—*Laurencia pinnatifida.*
" " — " *obtusa.*
" " — " *virgata.*
" " — " *perforata.*
" LIPUUPUU—*Laurencia* sp.
" LOLOA—*Gelidium* sp.
" LUAU—*Porphyra leucostica.*
" MANAUEA—*Gracilaria coronopifolia* J. Agh.
" MANEONEO—*Laurencia papillosa* (Forst.) Grev.
" MANU—See ILIO.
" MOOPUNA—See AUPUPU.
" NEHE—*Spirogyra* spp.
" NEI—See AWIKIWIKI.
" OLIPEEPEE—See MANEONEO.
" OOLU—*Champia compressa* Harv.
" " —*Chondria tenuissima.*
" PAHAPAHA—*Ulva fasciata* Delile.
" PAKAEA—See LIPALAHALAHA.
" PAKAELEAWAA—See HULUHULUWAENA.
" PALAHALOHA—See PAHAPAHA.
" PALAWAI—*Hydrodictyon reticulatum* (L.) Lagerh.
" " —See NEHE.
" PEPEIAO—*Padina pavonia.*
" " — " *Durvillei.*
" " —See LIPEPEIAO.
" PIPILANI—*Enteromorpha flexuosa* (Wulf.) Agh.
" PUAKI—*Liagora decussata.*
" PUALU—See HAWANE.
" UAUALOLI—*Gymnogongrus vermicularis americana* J. Agh.
" WAWAE-IOLE—See HULU.
" " —See AALAULA.
" WAWAHIWAA—See KAUPAU.
" WAWAIMOA—See AALAULA.

LIST OF FUNGI.

PEPEIAO AKUA—*Hirniola polytricha* Mont.
KALUKALU—A species of Truffle.

LIST OF LICHENES.

UNAHE—*Parmelia.*
KUAALA—*Peltigera podydactyla* var. *dolichorhiza.*
LIMU HAEA—*Stereocaulon claviceps.*
UNAHE—*Parmelia perlata.*

LIST OF HEPATICS AND MOSSES.

LIMU KOHA—A hepatic.
LIMU AHUULA—A moss.
LILILEHUA—A moss of fern-like habit covering tree trunks.
LIMU HOLOAWAI—A moss growing on rocks submerged in streambed, dark green.
LIMU AHI—A hepatic growing on trees.
HINEHINEULA—A moss.
HULUHULUAILIO—A moss.
LIMU HUNA—A moss of fine thread-like branches.
LIMU ALANI—A moss.
LIMU KAHA—A hepatic.
LIMU WAIKOI—A hepatic.
WAIOKILA—Evidently a moss.

Seaweeds have often the same native name as Liverworts or Mosses. The Hawaiian idea of creation is shown in a temple poem called PULE HEIAU, wherein it is stated that every plant created in the sea had its counterpart on land, which guarded the other with vigilance in the strife for existence. Hence evidently the same names for land plants.

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BOTANICAL BULLETIN No. 3. DECEMBER, 1916

Territory of Hawaii

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The Sandalwoods of Hawaii

A REVISION OF THE HAWAIIAN SPECIES OF THE GENUS SANTALUM

BY

JOSEPH F. ROCK
Consulting Botanist

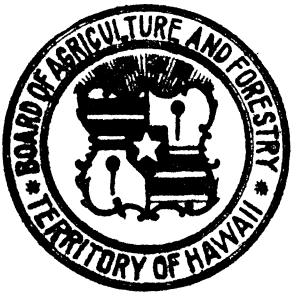

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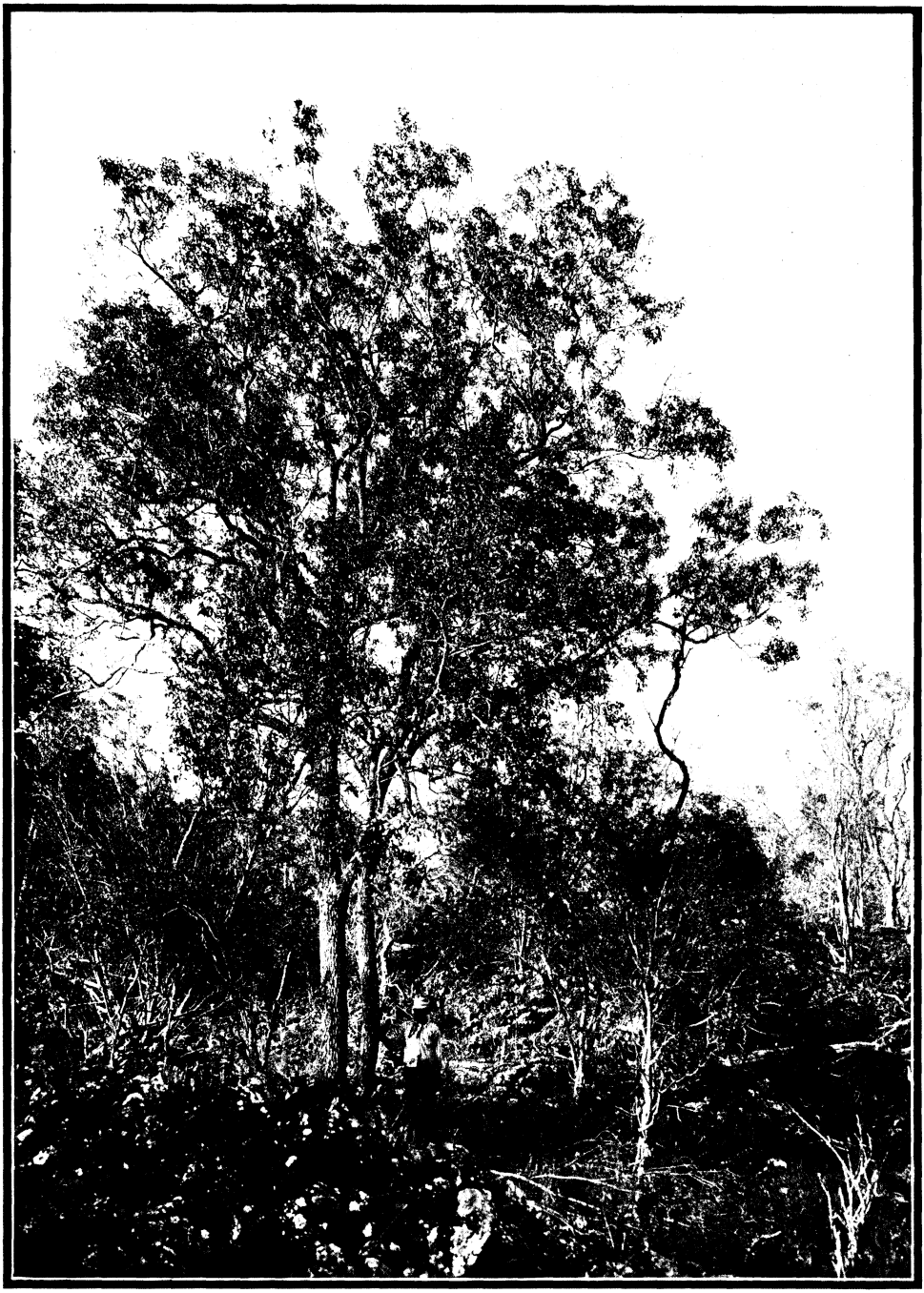
Plate I.



Santalum Pilgeri var. **luteum** Rock, growing on the lava-fields of Puuwaawaa, North Kona, Hawaii, elev. 2700 feet.

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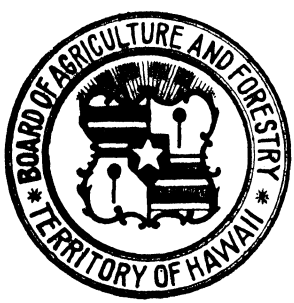
Issued December 28, 1916



HONOLULU, T. H., 1916

LETTER OF TRANSMITTAL

HONOLULU, HAWAII, October 1, 1916.

Board of Commissioners of Agriculture and Forestry,
Honolulu, Hawaii.

GENTLEMEN:

I have the honor to transmit herewith the manuscript of a paper entitled "The Sandalwoods of Hawaii," which is a revision of the Hawaiian species of the genus Santalum by Mr. Joseph F. Rock, *Consulting Botanist of the Division of Forestry, and Botanist of the College of Hawaii*, and to recommend that it be published as Botanical Bulletin No. 3 of the Division of Forestry.

This paper is the result of careful research on the part of Mr. Rock, who has straightened out the confusion which existed in regard to the proper botanical classification of the Hawaiian sandalwoods, and will no doubt be of interest to those in these Islands who are not acquainted with the nine species and two varieties of sandalwood.

Very respectfully,

C. S. JUDD,
Superintendent of Forestry.

Approved:

Board of Commissioners of Agriculture and Forestry,
October 5, 1916.

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HISTORY OF THE SANDALWOOD TRADE IN THE HAWAIIAN ISLANDS.

Up to the middle of the eighteenth century sandalwood was exclusively obtained from the East Indies, furnished by *Santalum album.* But after Captain Cook and his successors made Europeans familiar with the geology of the South Seas, enterprising traders went in search of the wood among the innumerable islands which dot the broad Pacific. The first group visited from Manila was Viti or Fiji. The sandalwood of that group, confined to the Island of Vanua Levu and derived from *Santalum Yasi,* a middle-sized tree, had long been famous in those waters and induced Tongans to undertake regular trading expeditions to the place where it grew, and they even attempted to transplant the tree to Tonga. So great was the demand for the wood, both in Polynesian and Chinese markets, that, about 1816, there was scarcely enough left for home-consumption and in 1840 the U. S. Exploring Expedition had difficulty in obtaining a few herbarium specimens.

About 1778 the attention of the commercial world was first directed to the existence of sandalwood in these Islands. A Captain Kendrick of a Boston brig is known to have been the first who left two men on Kauai to contract for several cargoes. The natives term the wood *Laau ala* meaning "fragrant wood," while they call the tree *Iliahi;* the species *(S. littorale)* growing near the sea they call *Iliahi aloe.*

Mention is made of the magnificent groves that formerly covered parts of these islands, especially the stony, and well drained places, where now only single individuals may be found, save on Hawaii, in the district of South Kona, where small groves still exist, but already in a dying condition.

The infant kingdom of Hawaii, under the government of the first Kamehameha, exported vast quantities of the wood. The sandalwood was to these Islanders the start in life, and it is doubtful if Kamehameha would have succeeded so well, had it not been for the profitable trade in sandalwood which he carried on with outsiders.

From 1790 to 1820 numerous vessels called for sandalwood, bringing all sorts of things in exchange, and about 1818 Kamehameha and his people began to accumulate considerable wealth. In one year alone 400,000 dollars were realized. Kamehameha

hearing of the great profits derived from sales in China determined to send a ship of his own to Canton laden with the produce. Extravagant port charges and misconduct of the English captain, etc., led to the commercial failure of this enterprise, and the king found himself 3,000 dollars out of pocket.

Under the reign of his successor (Liholiho), the sandalwood began to be exhausted, though in 1820, the records show that 80,000 dollars worth of the wood had been paid for the barge "Cleopatra"* and in 1822 we hear of a voyage to Kauai to collect the annual tribute of the wood in that Island.

But the product became every day more difficult to procure and could no longer be demanded in payment of taxes. However, quantities of the wood were now and then brought together, but they were quite insufficient to fill whole vessels as in times gone by.

Another very fragrant wood was discovered about that time, the *Naio* of the natives, *Myoporum sandwicense* A. Gray, belonging to an entirely different family. It was used as a substitute but could not revive the trade.

In November, 1829, a vessel arrived at these Islands from which it was learned that an island in the south Pacific had been discovered which harbored quantities of the much sought for sandalwood.

Boki, the Governor of Oahu, was made acquainted with the situation and he, full of enthusiasm and delighted with a chance of retrieving his ruined credit, accepted the proposition to fit out an expedition for taking permanent possession of it. Two men-of-war-brigs, the "Kamehameha" and the "Becket" were selected for the purpose, and after having been well provided with ammunition, arms, and stores for colonization, the expedition started on its eventful voyage. Nearly 500 people, including ten foreigners, embarked in these two vessels, all intent on making a fortune. The boats stopped first at Rotuma,* north of Fiji, and there discontent began to show itself due to the hardships of the voyage.

The destination turned out to be the Island of Eromanga,* and the "Kamehameha" having completed her preparation, started ten days in advance of her consort, but she was never heard of

*If a vessel was to be bought, the chief agreed to give an amount of sandalwood, in exchange, equal to the bulk of the craft; taking her greatest length, depth, and breadth, a pit of the same extent was dug, making no allowance for bilge, which was filled with sandalwood, and this amount exchanged for the desired object.

*Rotuma, Rotuam or Grenville Island, discovered by Capt. Edwards in 1791; 8 miles E-W, 2 miles N-S. 800 feet high.

*Eromanga is a high and rocky island of the New Hebrides, 30 miles by 32 miles.

again. The "Becket" reached Eromanga in safety and remained there some weeks, committed outrages on the natives, which led to hostilities which completely frustrated the object of the expedition. The "Kamehameha" not arriving, and a distemper breaking out, which carried off many of the company, including the commanding chief, the "Becket" resolved to return home.

A scene of horror now ensued which baffles description; crowded with the sick and dying and the dead, the vessel, slowly making her way through the sultry regions of the tropics, became a floating morgue. The sufferings of the survivors were aggravated by the want of water, food and medicines. Out of two hundred and twenty-six souls that comprised her company on leaving Rotuma, only twenty, eight of whom were white men, returned home. When she arrived at Oahu, on the 3rd of August, 1830, weeping and wailing could be heard night and day. The loss of so many active and fine men was felt as a national calamity and formed a sad conclusion of the sandalwood trade of these Islands.

THE HAWAIIAN SPECIES OF THE GENUS SANTALUM.

The genus *Santalum* is represented in the Hawaiian Islands by nine species and two varieties.

According to the old arrangement, as carried out by Hillebrand and other writers, the Islands were accredited with three species—*S. Freycinetianum, S. Pyrularium, S. Haleakalae,* and four varieties belonging to *S. Freycinetianum.* This erroneous classification followed by several authors, such as Gray, Hillebrand, Mann and the writer, was due to Gaudichaud's badly figured type of *S. Freycinetianum* in the Atlas of Bot. Voyage Uranie. The plate in that Atlas does not at all agree with the typical specimen of *S. Freycinetianum* collected by Gaudichaud on the Island of Oahu in 1827, which the writer had occasion to examine while working in the herbaria in Europe.

The Hawaii species of Santalum with obconical perigonal tubes were taken for the typical *S. Freycinetianum,* while the true *S. Freycinetianum* of Gaudichaud from the eastern division of Oahu was referred at least by Hillebrand and the writer to *S. ellipticum.*

Santalum Freycinetianum has not an obconical perigonal tube but a campanulate one, and belongs therefore to the group with *S. ellipticum, S. pyrularium, S. Lanaiense* and *S. Haleakalae.* Of the four former varieties of *S. Freycinetianum,* three—*paniculatum, cuneatum* and *littorale,* which have all obconical, yellowish perigones — have been raised to specific rank in the group of which *S. Pilgeri,* a distinct and new species, with an obconical perigonal tube, is the type. This latter species was referred to *S. Freycinetianum,* erroneously by various authors, but differs considerably from it. No doubt all these species have probably originated from two species which have been selected as the types of these two naturally defined groups; of the first group *S. pyrularium* may be the ancestor of the other species in that group, while *S. Pilgeri* may be the ancestor of the species of the second group. They are certainly closely related.

The genus is represented on all the islands of the group and ranges as far northwest as Laysan Island, which possesses a variety of *S. cuncatum* (var. *laysanieum*). The species *cuneatum* occurs only in the very dry and arid regions of Lanai

and on the lava flows of East Maui; it is therefore not surprising to find a variety of it on the barren island of Laysan. Nearly all of the Hawaiian sandalwoods prefer the drier regions, especially open rocky situations, from near sea level to over 5,000 feet elevation. On Hawaii they occur exclusively on lava flows, ranging from 2,500 to 5,000 feet in altitude, and curiously enough mainly on *aa* (rough) lava and rarely on *pahoehoe* (smooth) lava.

Santalum Pilgeri, probably the tallest and largest species, inhabits the *aa* flows on the southern slopes of Mauna Loa at an elevation of 5,000 feet near Pulehua, and forms almost a pure stand, but occurs also scattered in the forest bordering the big central plain, in company with *Acacia Koa, Myoporum sandwicense* and *Sophora chrysophylla.* This is the largest grove now extant.

Everywhere else in the group the various species of sandalwood occur only scattered here and there, as individuals.

Santalum littorale is still quite common in small gulches below the lighthouse on the slopes of Diamond Head on Oahu, where it is a small shrub several feet in height. The typical *S. Freycinetianum*, the first species described from these Islands in 1830 by Gaudichaud, is still quite abundant on the lower and middle slopes in Palolo Valley, but since the planting of pineapples on some of the lower ridges, it, as well as many good *koa* trees which were perhaps coincidentally its host, had to make way for the pineapples.

On Kauai sandalwood is very scarce and is found only in the outskirts of the forests, especially at Halemanu and Kaholuamano, at an elevation of from 3,000 to 3,500 feet. One species *S. pyrularium* is peculiar to Kauai, while *S. ellipticum* occurs on Kauai (eastern division) and also on the western range of Oahu.

Santalum Haleakalae, as the name implies, is peculiar to Haleakala on Maui, where it grows on old lava flows at an elevation of from 7,000 to 9,000 feet; the writer found it, however, considerably lower on the same mountain, but on the southern slopes.

S. paniculatum inhabits the open rocky situations near the Volcano of Kilauea, on cliffs and in deep lava cracks, and fissures caused by earthquakes, as well as on the lava plains toward Mauna Loa, but there always as a tree.

Sandalwood must certainly have formed a large percentage of the tree growth in the drier regions or mixed forests, in

the early days, before the value of the wood became known to the natives of these Islands. It must have existed in pure stands, or as forests, or it would have been next to impossible to export as much as $400,000 worth per annum.

Sandalwood is a hemiparasite; that is, it absorbs its nutriment not entirely from the ground but also from the roots of other trees (hosts) by means of *haustoria,* or suck organs, which are very numerous on the roots of sandalwood trees and which they sink into the roots of their hosts.

It is, however, not a parasite like the mistletoe, which is entirely dependent on its host for food, but can grow quite independently and even in pure stands as can still be observed on the lava fields of Kona, Hawaii.

The writer observed also *S. cuneatum* growing all alone with no trees or other plants near it within a radius of a mile, on the eastern end of Lanai. This proves conclusively that it is not always dependent on other trees for food.

The Oil of **Santalum Freycinetianum** Gaud.

By ALICE A. BALL,

Instructor in Chemistry, College of Hawaii.

A representative portion of the log of *Santalum Freycinetianum* was rasped as finely as possible and the resulting product steam distilled. The distillate was extracted with ether to remove the oil. The ethereal solution was dried with anhydrous sodium sulphate and the ether removed by distillation. The resulting oil amounting to .75-1% of the weight of the wood taken, was a clear yellow, somewhat thick liquid of a characteristic aromatic odor, but much milder and less pungent than the sandalwood oil of commerce. The specific gravity at 25° C. compared with water at 4° C. was .97. The refractive index at 26° C. was 1.5040. The oil was assayed for santalol according to the method outlined in the U. S. Pharmacopeia VIII, and the percentage of santalol found to be 96-97%. The acetylated oil gave a refractive index of 1.4890 at 26° C.

From the above data it is readily seen that the oil of this species of sandalwood compares favorably with the better grade of oil of *Santalum album,* which assays from 90-98% santalol. The oil of *Santalum Freycinetianum* meets the requirements of sandalwood oil according to the U. S. Pharmacopeia VIII.

The above analysis was made at the Chemical Laboratory of the College of Hawaii.

SYSTEMATIC PART

Key to the Hawaiian Species of Santalum.

Perigonal tube campanulate to cylindrical:
- Drupe ovate, smooth:
  - Inflorescence terminal:
    - A raceme or panicle, flowers many:
      - Leaves ovate-oblong, on petioles of 1-2 cm..... ..... **S. Freycinetianum**
    - A bracteate corymb:
      - Leaves obovate-oblong .... **S. Haleakalae**
  - Inflorescence axillary:
    - Flowers large and few:
      - Leaves large, orbicular .... **S. Lanaiense**
    - Flowers loose, few, paniculate:
      - Leaves elliptical-oblong .... **S. ellipticum**
- Drupe obovate, large, rough .... **S. pyrularium**

Perigonal tube obconical:
- Drupe ovoid:
  - Inflorescence a short axillary raceme, flowers in clusters of 3-6, orange yellow:
    - Leaves ovate to obovate, large, dark green .... **S. Pilgeri**
  - Inflorescence a large, terminal, densely flowered panicle:
    - Leaves chartaceous, large, ovate to suborbicular, glaucous .... **S. paniculatum**
- Drupe globose to subglobose:
  - Inflorescence a short panicle in the axils of the leaves:
    - Leaves thick, coriaceous, orbicular to suborbicular, with truncate to cuneate base .... **S. cuneatum**
  - Inflorescence terminal and axillary, flowers small, fragrant:
    - Leaves small, ovate-elliptical, glaucous .... **S. littorale**

Plate II.

Santalum Freycinetianum Gaud. (Typical specimen from Palolo Valley, Oahu.)

Santalum Freycinetianum Gaud. Bot. Voy. Uranie, 442, t. 45, 1830.

Santalum Freycinetianum Gaud. δ var. *ellipticum* Hbd. Fl. Haw. Isl. 390, 1888, in part.

Santalum ellipticum Rock (not Gaud.) Indig. Trees Haw. Isl. 131, 1913.

A small tree with slender, drooping branches, glabrous throughout; leaves ovate-oblong, acute, tapering at both ends, thin, chartaceous, glossy above, dull underneath, dark green, with reddish tinge, 5-7 cm. long, 1.5-2 cm. wide, on slender reddish petioles of 1-2 cm.; inflorescence a simple terminal raceme 5-7 cm. long, flowers opposite or in clusters of 3-6, rarely more, on pedicels of 3 mm., or occasionally subsessile; perigone reddish as is the whole inflorescense, 4-6 mm. long, campanulate, the acute, ovate lobes as long as the tube; disk-lobes short and broad; anthers slightly longer than the filaments, tufts of hair as long as the stamen or slightly shorter; style nearly as long as the perigone, slender, with 3 capitellate lobes; drupe ovoid, 10 mm. long, with truncate apex and smooth putamen.

Oahu, eastern division, Palolo Valley.
Wahou (Oahu) Gaudichaud 1827, Ins. Sandwic., in Herbarium, Berlin.
Wouhala Oahu, Sandwich Islands, G. Bennett, December, 1830, in Herbarium, Berlin.
Oahu, Palolo Valley, Rock No. 10063, flowering, March, 1910, and No. 12512 flowering, September, 1912; in Herbarium, College of Hawaii.

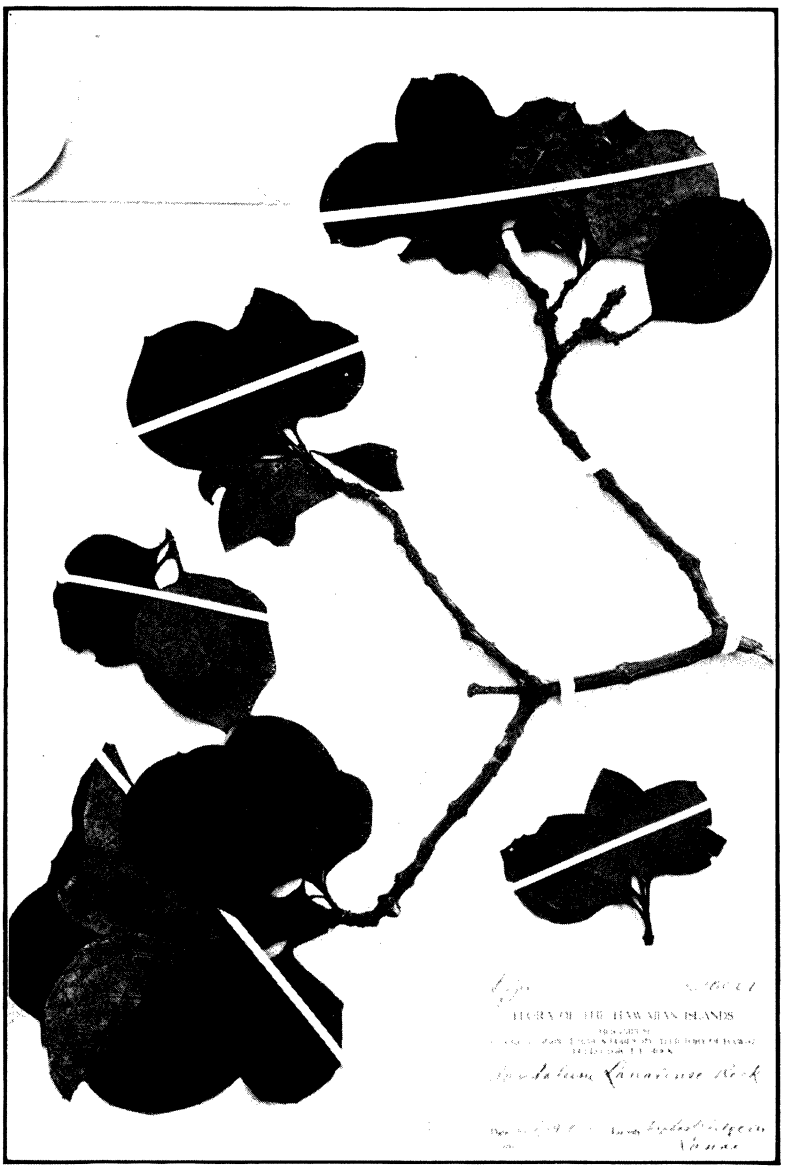
This is the typical *Santalum Freycinetianum* Gaud. It occurs on the Island of Oahu on the eastern division and is quite common in Palolo Valley at an elevation of 600-1,500 feet; at the lower levels it is associated with *Acacia Koa* which is probably its host. At the higher level it grows in company with *Straussia kaduana, Elaeocarpus bifidus, Wikstroemia* and others.

This plant was confused by several writers, including the present one, with *S. ellipticum* Gaud.

In the Herbarium at Berlin (Royal Botanical Museum) there are two sheets of this species, one collected by Gaudichaud in 1827 part of the type, labeled *Santalum Freycinetianum* Gaud. It is identical with the plants from Palolo Valley. The second sheet is a specimen collected by G. Bennett* on Oahu in December, 1830, and bears the following label: "Santalum, Sandalwood

* Dr. George Bennett of Sydney, a veteran explorer.

Plate III.



Santalum Lanaiense Rock, type specimen.

Tree, Native name Iliahi or Lauhala.* Wouhala, Oahu, Sandwich Islands, December, 1830. The tree is of slow growth and inhabits elevated and rocky situations. G. Bennett." Bennett's plant is identical with Gaudichaud's specimen of *S. Freycinetianum.*

There are two distinct Santala occurring on the Island of Hawaii which were always referred to *Santalum Freycinetianum* Gaud., but are entirely different plants.

The plate in the Atlas of Gaud. Bot. Voy. Uranie does not quite coincide with the specimen collected by Gaudichaud which is the type, and of which a portion (ex. herb. Mus. Paris) is deposited in the Berlin Herbarium. The plates in general, issued under the above cited title, are quite inferior to those published by Gaudichaud in the Atlas of Bot. Voyage Bonite.

Santalum Lanaiense Rock

Santalum Freycinetianum Gaud. var. *Lanaiense* Rock, Indig. Trees Haw. Isl. 129, 1913.

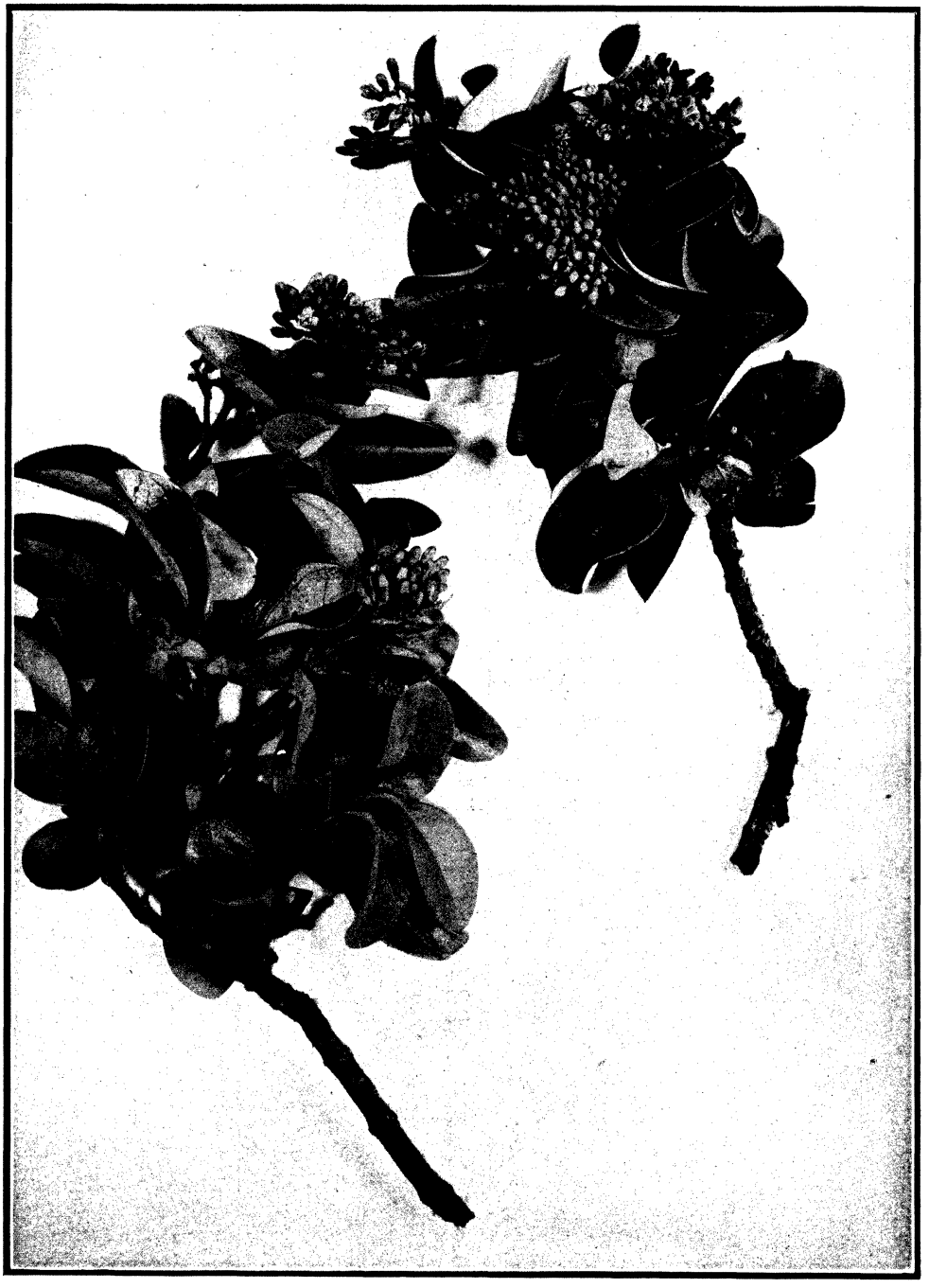
A small gnarled tree, with stiff robust branches; leaves large orbicular in outline, 7-10 cm. each way, dark green above, dull on both sides, bright glaucous underneath, with red veins, chartaceous, mucronate at the apex, rounded or contracting at the base into a petiole of 5 mm.; inflorescence very small 2.5 cm., flowers in pairs or single on minute pedicels, large, bright red, with a glaucous hue, perigone 12 mm. long, campanulate to cylindrical, the acute lobes a third the length of the tube; disk with obtuse lobes of 1 mm.; filaments as long as the anthers, the tufts of hair nearly the length of the stamens; style 8 mm. long; slender, the stigmatic lobes short and blunt; drupe unknown.

Lanai: Highest ridge, Haalelepakai, elevation 3,000 feet, flowering July, 1910, Rock, type No. 10061 in the College of Hawaii Herbarium.

A remarkable tree, with the largest leaves of any Hawaiian Santalum; it belongs to the group with *S. Haleakalae* and *S. pyrularium*, the flowers are large, broadly campanulate and bright red.

*Probably **Laauala**—fragrant wood, instead of **Lauhala** which is the native name for **Pandanus tectorius.**

Plate IV.



Santalum Haleakalae Hbd.

Santalum Haleakalae Hbd. Fl. Haw. Isl. 390, 1888.
Santalum pyrularium Gray var. β Gray in mss. U. S. E. E.

A tree 3.5 m.—4.5 m. high with stiff gnarled branches at high elevation, longer slender branches at lower elevation; bark gray, corrugated; leaves coriaceous (chartaceous at lower elevations), ovate to obovate-oblong- or elliptical, dull green, with reddish midrib and veins, 3-5 cm. long, 2.5-3 broad, acute or rounded at both ends, on petioles of 3-6 mm.; inflorescence terminal, constituting a dense corymb of 8-10 cm. in length and as broad, flowers subsessile, deep carmine red, the perigonal tube 8-10 mm., the acute lobes nearly as long, disk lobes lanceolate longer than the filaments, the latter shorter than the anthers, the tufts of hair as long as the stamens; style exserted, 1 cm. long, 3—cleft, the lobes 0.5 mm.; drupe ovoid, 12x9 mm., purplish-black; with a blunt conical vertex.

Maui: Haleakala, Hillebrand, July, 1858; in Herbarium Berlin;—Mann & Brigham No. 396;—Northeastern slope of Mt. Haleakala, Puunianiau Crater, elevation 7,000-9,000 feet, flowering and fruiting, Rock No. 8588 in College of Hawaii Herbarium. Southern slopes of Mt. Haleakala, lava fields of Auahi, Kahikinui elevation 3,000 feet, flowering, November, 1910, Rock No. 8659 in the College of Hawaii Herbarium.

In the Berlin Herbarium are three sheets, two collected by Hillebrand without number, in July, 1858, on Haleakala, and are labeled *Santalum paniculatum* H. et A., both however are typical *S. Haleakalae* Hbd.

The third sheet also labeled *S. paniculatum*, comes from Kauai, leg. Knudsen No. 171, but is hardly referable to this species.

S. Haleakalae comes indeed very close to *S. pyrularium* and *S. ellipticum* and may be in fact an intermediate between these two species. The writer's No. 8659 comes from a much lower elevation, and it is this plant which comes especially close to the Kauai species. The leaves are chartaceous and much larger, the inflorescence is, however, different and of a bright carmine red.

It has nothing in common with *S. paniculatum*, which has a small obconical perigonal tube.

Santalum ellipticum Gaud.

Santalum ellipticum Gaud. Bot. Voy. Uranie, 442, 1830.

Santalum Freycinetianum Gaud. var. ϵ *ellipticum* Gray in Mann Enum. Haw. Pl. Proc. Am. Acad. 7:198, 1868.

A smaller tree than **S. pyrularium,** trunk shorter, branches slender; leaves chartaceous to subcoriaceous, elliptical-oblong, acute or obtuse at the apex, dull green on both surfaces, glabrous 6-10 cm. long, 15-25 mm. wide, on slender petioles of 10-12 mm.; panicles in the axils of the upper leaves; pedicels 2 mm.; perigonal tube shorter than in **S. pyrularium,** 6-10 mm., the somewhat acute, oblong, reddish lobes 5-6 mm., diskus-lobes slightly shorter than the filaments, the anthers as long as the latter; style as in **S. pyrularium;** drupe smaller, 14 mm., ovoid, with a conical vertex, putamen slightly rough.

Kauai: Hbd. (Knudsen)?;—Halemanu near Puukapele, flowering February 14-26, 1909, Rock, No. 1816 in College of Hawaii Herbarium; forests of Kaholuamano, elevation 3,500 feet, flowering and fruiting March 3-10, 1909, Rock, No. 1822 in College of Hawaii Herbarium Oahu: western range Mt. Kaala, Hillebrand, in Herbarium Berlin without number, and College of Hawaii Herbarium, ex. Mus. Bot., Berlin.

Gaudichaud's plant is without number or locality other than Sandwich Islands. His specimen probably came from Oahu.

The Oahu specimens of this species from the Kaala range differ from those of *S. Freycinetianum* from Palolo Valley of the same island. The leaves remind of those of *S. pyrularium.* It is undoubtedly an intermediate between *S. pyrularium* and *S. Freycinetianum,* and is more allied to the former, as it also occurs on Kauai and only on the Waianae range on Oahu, the vegetation of which range is remarkable for its similarity to that of Kauai.

It differs mainly from *S. pyrularium* in the drupe, which is much smaller in *S. ellipticum,* and the less rough or rather smooth putamen.

Plate VI.

Santalum pyrularium Gray. Fruiting specimen.

Santalum pyrularium Gray Proc. Am. Acad. 327, 4: 1860.

A tree 10-15 m. high, with slender, more or less ascending branches, glabrous throughout; leaves dull green, with reddish veins and petioles, somewhat glaucous underneath, elliptical-oblong, acute or acuminate at the apex, 7-10 cm. long, 3-4 cm. wide, subcoriaceous, acute at the base, on petioles of 1-1.5 cm.; panicles axillary about 2.5 cm., loosely few-flowered, pedicles about 3 mm.; perigone dull red, cylindrical, 12-14 mm. long, the lobes 6-8 mm., disk lobes narrow, obtuse, nearly as long as the filaments, the anthers as long as the filaments; tufts of hair long; style slender, as long as the perigone (including the lobes), stigma three-cleft,; drupe large, obovoid, nearly 2 cm. long, with a small conical apex, the putamen rough, runcinate.

Kauai: U. S. E. Exped.;—Hillebrand, a fragmentary specimen in the Herbarium Berlin;—Gebiet um Halemanu, Wawra No. 2137, 2342 in Herbarium Vienna;—Halemanu, forest of Kopiwai and Halemanu proper, elevation 3,600 feet, flowering and fruiting, February 14-26, 1909, Rock, No. 1834 in the College of Hawaii Herbarium.

This very distinct species inhabits the outskirts of the forests as well as the semi-dry mixed forests of Kauai, especially Halemanu and Kaholuamano, where it grows in company with *Elaeocarpus bifidus, Tetraplasandra Waimeae, Pterotropia kauaiensis, Bobea Mannii, Straussia, Alphitonia excelsa* and others. When growing farther inland on the borders of the rain forests it develops a straighter trunk and is also taller.

It differs from the other related *Santala* in the long, oblong-elliptical leaves, large cylindrical perigone, but mainly in the large, obovate drupe, with the runcinate, rough putamen. *Santalum ellipticum* Gaud. may only be a variety of this species, and may be intermediate between this species and the typical *S. Freycinetianum* from Palolo Valley, Oahu.

The specimen in the Berlin Herbarium is only fragmentary.

Plate VII.

No. 1834
FLORA OF THE HAWAIIAN ISLANDS
HERBARIUM
BOARD OF AGRICULTURE & FORESTRY, TERRITORY OF HAWAII
COLLECTOR J. F. ROCK
Santalum pyrularium A. Gray
Date Feb. 14 1909 Locality Hoolemanu forest Kauai

Santalum pyrularium Gray. Flowering specimen.

Santalum Pilgeri Rock, n. sp.

Santalum Freycinetianum Hbd. (not Gaud.) in part, Fl. Haw. Isl. 389, 1888.

Santalum Freycinetianum Rock (not Gaud.) Indig Trees Haw. Isl. 127, 1913.

A tall tree 14-16 m. in height, with a straight trunk 3.4 dm. in diameter, bark black, smooth, branches straight, more or less ascending, leaves opposite, dark green, glossy, glabrous on both surfaces, with a strong, prominent midrib, ovate to obovate, obtuse or slightly pointed at the apex, 6-10 cm. long, 3-5 cm. wide, acute at the base, on a somewhat margined petiole of 4-6 mm.; the foliate branchlet slightly flattened with prominent lateral ridges, or almost alate; racemes short, axillary in the upper leaves, 1.5-3.5 cm. long, flowers sessile or subsessile in clusters of 3-6 or more; perigone orange-yellow, the tube exceedingly short, obconical, 3 mm. high, the broad acute lobes 2 mm.; lobes of disk broad, sinuses broad and deep, tufts of hair rather short, anthers longer than the filaments, hiding the latter; style reaching to half the length of the tepala, minutely three-cleft; drupe ovoid, smooth, black, truncate at the apex.

Hawaii: Kona, Hillebrand, 1862, in Herbarium, Berlin, and College of Hawaii Herbarium.
South Kona, Pulehua on *aa* (rough) lava flows above Kealakekua, elevation 5,000 feet, bordering the great central plain, Rock, flowering and fruiting Feb. 10, 1912, type No. 10033 in the College of Hawaii Herbarium.

This remarkable species which was confused with *S. Freycinetianum* is very distinct and differs from it in its habit, the short obconical perigone, the large, stiff, dark green leaves, and short axillary inflorescence, as well as large, ovoid drupe, with the projecting limb of the perigone.

It is a large tree reaching a height of 40-50 feet and even more and forms quite a little forest of its own on an *aa* (rough) lava field near Pulehua, on the southern slopes of Mauna Loa, at an elevation of 5,000 feet. It is remarkable for its tall, straight trunk, of often nearly 2 feet in diameter, and the black, perfectly smooth bark.

In the Herbarium of the Royal Botanical Museum at Berlin, there is one sheet collected by Hillebrand and labeled *Santalum Freycinetianum* var. *Gaudichaudii*, Kona, Hawaii, 1862. Prof. Pilger who had revised the Santalaceae preliminarily, recognized it as a distinct species and marked it *Santalum affine* n. sp. Pilger. The plant is here named for Prof. Pilger. The specimen in the Berlin Herbarium is identical with the writer's plants from Pulehua, Kona, Hawaii.

Plate VIII.

Santalum Pilgeri Rock Type.

Santalum Pilgeri var. **luteum** Rock, n. v.

A medium sized tree 10-15 m. high, with a straight trunk 3 dm. or more in diameter, bark dark gray, deeply corrugated, several centimeters thick, branches stiff; leaves thin, chartaceous, ovate-oblong to elliptical, acute at both ends, 6-8 cm. long, 2.5-3.5 cm. wide, glossy shining above, yellowish-green and dull underneath, on petioles of 1 cm.; inflorescence paniculate, and axillary, the rhachis short 1-1.5 cm., pubescent throughout, perigone smaller than in the species, the obconical tube less broad, 2.5 mm., otherwise as in the species; drupe ovate, the size of a ripe olive, 14 mm. long and 9 mm. thick, purplish-black, with an acute conical vertex, putamen smooth.

Hawaii: On the lava flows of South and North Kona; Huehue to Puuwaawaa, North Kona, slopes of Mt. Hualalai, elevation 2,000-3,000 feet, flowering June, 1909, Rock, type No. 3728 in the College of Hawaii Herbarium;— Kapua, South Kona, flowering January, 1912, Rock No. 12515 in the College of Hawaii Herbarium.

This variety is not uncommon on the lava flows between Huehue and Puuwaawaa, along the government road where it is a small tree, while on the slopes of Mt. Hualalai, a thousand feet higher, it is a big tree, 40-45 feet in height. It differs from the species in the gray, deeply corrugated bark, yellowish, ovate-elliptical, thin leaves, and the olive shaped drupe which is crowned with an acute, conical vertex. The trees from Kapua, South Kona, are much smaller than those from Puuwaawaa.

Santalum Pilgeri var. **luteum** Rock. Flowering and fruiting specimens, type.

Santalum paniculatum Hook et Arn. Bot. Beech. Voy. 94, 1832.

Santalum Freycinetianum Gaud. var. *latifolium* A. Gray Proc. Am. Acad. 327, 4: 1860.

A much branching shrub or small tree 4-6 m. high; leaves chartaceous to subcoriaceous, pubescent when young ovate to obovate, bright green above, glaucous underneath, rounded at the apex, contracting at the base into a very short, slightly margined petiole of 4 mm.; inflorescence paniculate, large, terminal, or in the axils of the upper leaves, covered with an olivaceous-grayish pubescence, panicles densely flowered, 5-10 cm. long; the subsessile perigone glaucous, slightly pubescent, the tube obconical 3 mm., the broad acute lobes 2 mm.; disk with broad shallow sinuses, the lobes short, rounded; anthers slightly longer than the filaments; tufts of hair the length of the stamen; style reaching to half the length of the tepala; the 3 minute stigmatic lobes capitellate.

Hawaii: U. S. E. Exped.;—Hualalai, Central plateau, Kilauea, Hbd. Nos. 400, 422, 490 in Herbarium of Berlin;—Kilauea Volcano, along trail, flowering Aug., 1911, Rock, No. 8770 in the College of Hawaii Herbarium;—Central Plateau, Puuoikaaka Crater, slopes of Mt. Hualalai, elevation 5,700 feet, flowering Feb. 13, 1912, Rock, No. 10048 in the College of Hawaii Herbarium;—Near Kilauea, in Shipman's paddock, growing in company with *Metrosideros polymorpha* and *Acacia Koa*, flowering and fruiting (immature) Oct. 30, 1915, W. M. Giffard, No. 12517 in the College of Hawaii Herbarium.

Maui: West Maui, Lydgate No. 157, in Herbarium, Berlin.

Molokai: Halawa, Hbd. in Herbarium, Berlin.

Lanai: Lydgate No. 156. Labeled, "*Santalum Freycinctianum* var. *obovatum*, small tree"; in Herbarium, Berlin.

Kahoolawe: Remy No. 507, specimen not seen by the writer.

The typical form of this species occurs on the Island of Hawaii, along the trail leading to the Volcano of Kilauea and in the immediate neighborhood of the Volcano House, along, and in large steam cracks. It is distinct from *S. Freycinetianum* Gaud. and differs from it in the large densely flowered, glaucous, panicle, the obconical tube of the perigone, which is as a whole much smaller; also in its habit of growth, being a shrub

Plate X.

Santalum paniculatum Hook. et Arn. Flowering specimen.

12 feet in height, and its large ovate to obovate glaucous foliage The numbers 400, 422, 490 (ex. Herb. Hillebrand) in the Berlin Herbarium are identical with the specimen of *Santalum paniculatum* H. et A. in the Kew Herbarium.

No. 12517 collected by W. M. Giffard is a small tree and is quite common near the Shipman ranch house as well as on the outskirts of the *aa* (rough) lava flows encircling the Kipuka Puaulu, also found beyond, along the trail to Kipuka Ki, elevation 4,000 feet. It is also not uncommon along the trail to Puuhuluhulu and Makaopuhi crater. It differs from the plants found in the fissures near the Volcano House, mainly in the smaller leaves which are ovate-elliptical, and in its habit, it being a small tree 15-25 feet in height.

Plate XI.

Santalum cuneatum (Hbd.) Rock. Typical form from Lanai.

Santalum cuneatum (Hbd.) Rock

Santalum Freycinetianum Gaud. var. γ *cuneatum* Hbd. Fl. Haw. Isl. 389, 1888.

A shrub with long rambling or even climbing branches, leaves thick, coriaceous, orbicular to suborbicular, slightly emarginate at the apex, base cuneate to truncate, 2-3 cm. in diameter, on petioles of 5-10 mm.; inflorescence in the axils of the leaves all along the branchlets; flowers slightly pedicellate, perigone glaucous, the tube obconical, 2-3 mm., the acute, spreading lobes 2 mm., yellowish; disk and stamens as in S. littorale, the style longer than the perigonal tube; drupe subglobose, 8 mm. in diameter, with a truncate apex, and the remnant of the style.

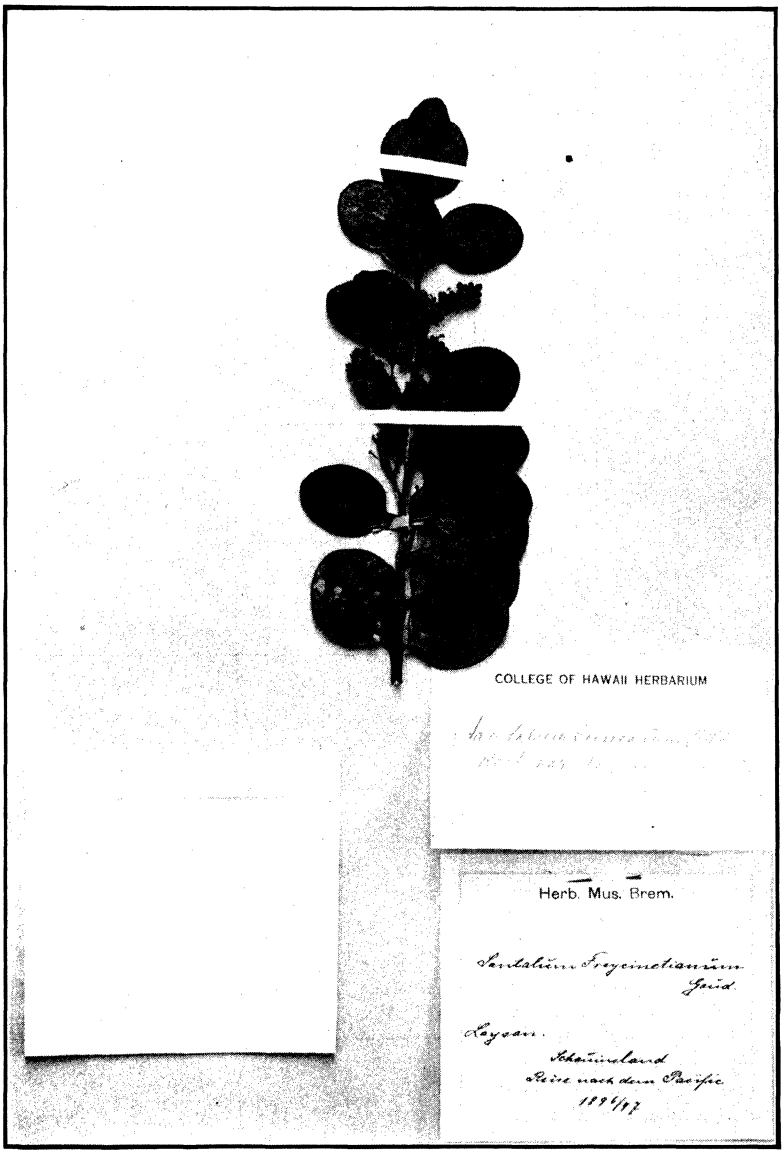
Lanai: Hillebrand, July, 1870, without number, one sheet in Herbarium, Berlin, and College of Hawaii Herbarium, ex Mus. Bot. Berlin.
Kaa Desert, western end of Lanai, elevation 2,000 feet, flowering and fruiting, found climbing on a Sideroxylon, July 27, 1910. Rock, No. 8004 in the College of Hawaii Herbarium;—Eastern end of Lanai on open, exposed, grassy places, flowering, July 29, 1910, Rock, No. 8013 in the College of Hawaii Herbarium;—Central part of Lanai, back of Koele on dry rocky slopes, on verge of Mahana Valley, flowering July 27, 1910, Rock, No. 8048 in the College of Hawaii Herbarium.
Maui: on lava fields of Auahi, Kahikinui, southern slopes of Mt. Haleakala, elevation 2,700 feet, flowering Nov., 1910, Rock, No. 8683.

The numbers 8013 and 8048 differ somewhat from No. 8004 and may be a form of the latter, the leaves are larger, ovate to suborbicular, the base is not quite truncate and the petioles are longer, otherwise the same. Of No. 8013, three small trees were observed growing alone, with no trees within a radius of several hundred yards.

No. 8683 is a small tree or shrub, almost identical with Nos. 8013 and 8048, the leaves are, however, still larger, otherwise the same.

This species is undoubtedly related to *S. littorale,* but differs from it in the thick, fleshy-coriaceous, orbicular leaves, with a truncate to cuneate base. It is a much larger shrub with long rambling, scandent branches, often climbing on other trees. Type in the Herbarium, Berlin, ex herb. Hillebrand.

Plate XII.



Santalum cuneatum (Hbd.) Rock var. **laysanicum** Rock; type.

Santalum cuneatum var. **laysanicum** Rock n. v.

Santalum Freycinetianum Bitter (non Gaud.) Abh. Nat. Ver. Bremen XVI: 3, 433, 1900.

A shrub 2.5 m., or higher, main stem 10 cm. in diameter, glaucous throughout; leaves orbicular-suborbicular, to ovate, thick-coriaceous to fleshy, 3.5-4.5 cm. both ways, rounded, or slightly acute at the apex (only in ovate leaves), truncate at the base, on petioles of 2.5 mm. or subsessile; panicles 2.5 cm., flowers sessile or subpedicellate; perigonal tube obconical, glaucous, 2 mm., the broadly-ovate, acute lobes 3 mm.; disk-lobes as long as the filaments, tufts of hair short, anthers ovate, shorter than the filaments; style exserted, 3-cleft, drupe obovate, 12 mm., black, ribbed (when dry), apex truncate.

Laysan Island: An der Uferzone der Insel, am üppigsten an der Nordwestseite, flowering 1896-1897, Prof. Schauinsland, No. 20, in Herbarium Museum Bremen, and in the College of Hawaii Herbarium;—Wm. A. Bryan, without number, flowering specimen in the College of Hawaii Herbarium;—D. T. Fullaway, flowering and fruiting Dec., 1912, in the College of Hawaii Herbarium.

This variety differs slightly from the species, but mainly in the larger leaves, and larger, obovate, ribbed drupe, otherwise as in the species, with the exception of stature which in the variety is a short stiff shrub, with stout branches and branchlets.

It grows near the beach, especially gregarious on the northwest side of the Island (teste Schauinsland), and is the largest plant on the Island.

Santalum littorale (Hbd.) Rock. Typical specimen from Diamond Head, Oahu.

Santalum littorale (Hbd.) Rock

Santalum Freycinetianum ϵ var. *littorale* Hbd. Fl. Haw. Isl. 390, 1888.

A low and stiff shrub 1-1.5 m. in height, with grayish gnarled branches, leaves glaucous or dull pale, small, 2.5-3.5 cm. long, 1.5-2 cm. wide, ovate to elliptical, coriaceous, with thickened margins, acute or somewhat obtuse, the veins not very prominent, on slender petioles of 5-10 mm.; flowers terminal and axillary, glaucous, fragrant, sessile or slightly pedicellate, brick red to yellowish; the perigonal tube not broadly obconical, 4 mm., the acute lobes 2 mm.; diskus lobes short, rounded, stamens little longer than the filaments, 1 mm.; style slightly protruding beyond the tube, the 3 minute stigmatic lobes capitellate; drupe globose, glaucous when young, 6-7 mm. in diameter.

Oahu: Kape Kaena, Waianae, seashore, and Kailua, Hbd. 1869, in Herbarium Berlin.
Diamond Head, near the government road and on slopes below the road, near sea, flowering 1910, Rock, No. 12513, in the College of Hawaii Herbarium.
Koko Head, flowering, G. W. Shaw, No. 12514 in the College of Hawaii Herbarium.
Hawaii: Shores Kealakekua, observed flowering February, 1912, Rock.

This interesting Santalum is worthy of specific rank; it cannot be retained as a variety of *S. Freycinetianum* Gaud. since it is more related to *S. Pilgeri* Rock, having an obconical perigonal tube instead of a campanulate-cylindrical one.

It belongs to the groups of *S. paniculatum, S. cuneatum,* and *S. Pilgeri,* all with an obconical perigonal tube, while *S. pyrularium, S. Freycinetianum, S. ellipticum* and *S. Haleakalae* possess more or less cylindrical perigonal tubes.

The type of this species is in the Berlin Herbarium (ex. herb. Hillebrand) without number.

ADDENDUM.

Through the courtesies of Miss Mary A. Day, Librarian of the Gray Herbarium, the writer has come into the possession of an article on the Genus Santalum by M. G. Meurisse entitled *"Etude du genre Santalum L."* published in *"Bulletin Mensuel de la Societe Linneenne de Paris,"* 1892.

In his article Meurisse describes a new species of Santalum, *S. longifolium,* based on a specimen collected by J. Remy on Oahu, and raised a variety *latifolium* of *S. Freycinetianum* to specific rank; his *S. latifolium* was, however, already described by Hooker et Arnott as a distinct species under the name *Santalum paniculatum*; the writer is unable to see why the much earlier specific name *paniculatum* should have been discarded for the newer name of Gray *latifolium.* His *Santalum longifolium* from Oahu is probably the narrow leaved form of the typical *S. Freycinetianum* from Oahu.

He also mentions of having described two varieties of *S. Freycinetianum* var. *vulgare* and *multinerve* but fails to mention if they came from the Hawaiian Islands or from one of the South Sea Islands, as *S. Freycinetianum* is supposed to occur in Tahiti from which place it was described under the name of *S. insulare* by Bertero. Meurisse states in conclusion that the complete description of the other species (none Hawaiian) and varieties may be found in *Bulletin des Sciences naturelles,* numbers March and April, 1892.

The writer has in vain tried to secure the loan of the above mentioned numbers from various libraries in the States; the publication mentioned being not available and seeming not to exist in America.

In fact one librarian states that she doubts if the articles were even published as no reference could be found anywhere, other than Meurisse's own of May, 1892.

The reference in Index Kewensis, Supplement One, page 379, regarding *S. longifolium* is wrong. In Index Kewensis it is given as coming from New Zealand, while Meurisse states Hawaiian Islands, Oahu. *S. Salicifolium* Meurisse is given in Index Kewensis as coming from Hawaii, while Meurisse states it to have been a variety of *S. Cunninghamii* from New Zealand.

Appended is the description of *Santalum longifolium* Meurisse, Bull. Soc. Linn. Paris, 1026-1027, 1892.

Feuilles très longues et très larges, ovales-aigues, longue-

ment atténuées à leurs deux extrémités, d'un vert sombre et lisses en dessus, plus pâles et ternes en dessous, à nervure principale surtout saillante inférieurement, à nervures secondaires nées à angle tres aigue, aussi visibles à la face supérieure qu'à la face inférieure, et devenant toutes parallèles aux bords du limbe qu'elles suivent jusqu'à son commet. Pétiole très long (le plus long de toutes les espèces vues jusqu'ici). Cymes composées, axillaires ou terminales, plus courtes que les feuilles. Fleurs courtement pédicellées, à périanthe profond, à lobes plus courts que le tube. Etamines à anthères égales à leurs filaments, écartées en X á la maturité et terminées supérieurement par deux petites cornes hyalines. Quatre faisceaux de poils longs en arrière de cellsci. Lobes du disque arrondis, aplatis. Style ordinairement plus long que le sommet des anthères—deux our trois stigmates, ovaire presque complètement infère, à placenta peu allongé, 2-ou 3-ovulé. (Limbe: long., 10 centimètres; larg., 3 centimètres et demi. Pétiole: 2 à 2 centimètres et demi. Fleur: long., 12 millimètres (av. pédicelle 2 millimètres et demi), larg., 4 millimètres.)

Forestry

BOTANICAL BULLETIN No. 4 AUGUST, 1917

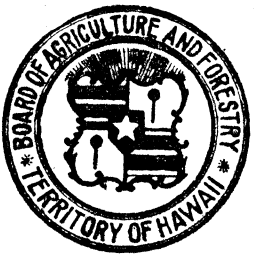
Territory of Hawaii
BOARD OF AGRICULTURE AND FORESTRY

DIVISION OF FORESTRY
C. S. JUDD, *Superintendent*

The Ohia Lehua Trees of Hawaii

A Revision of the Hawaiian Species of the genus Metrosideros Banks, with special reference to the varieties and forms of *Metrosideros collina* (Forster) A. Gray subspecies *polymorpha* (Gaud.) Rock.

BY
JOSEPH F. ROCK
Consulting Botanist



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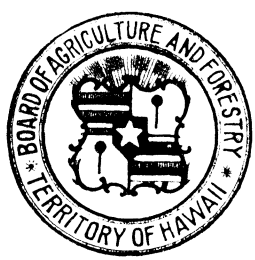
ISSUED AUGUST 27, 1917



HONOLULU, HAWAII

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1-22-1924

LETTER OF TRANSMITTAL

Honolulu, Hawaii, March 1, 1917.

Board of Commissioners of Agriculture and Forestry,
Honolulu, Hawaii.

GENTLEMEN:

I have the honor to transmit herewith the manuscript of a paper entitled "The Ohia Lehua Trees of Hawaii," which is a revision of the Hawaiian species of the genus *Metrosideros* Banks, with especial reference to the varieties and forms of *Metrosideros collina* (Forster) A. Gray subspecies *polymorpha* (Gaud.) Rock, by Mr. Joseph F. Rock, *Consulting Botanist of the Division of Forestry and Botanist of the College of Hawaii,* and to recommend that it be published as Botanical Bulletin No. 4 of the Division of Forestry.

Very respectfully,

C. S. JUDD,
Superintendent of Forestry.

Approved:

Board of Commissioners of Agriculture and Forestry,
March 8, 1917.

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PREFACE

The writer of this monograph had the privilege of examining herbarium material of the critical species of *Nania* in the herbaria of the Bureau of Science in Manila, P. I., and Botanic Garden of Buitenzorg in Java. He also saw living material of *Nania vera,* during the summer of 1916. He also was able to consult the original work of Rumph and other early works (with reference to Metrosideros) in the Libraries of the above mentioned institutions.

Through the kindness of Dr. L. B. Robinson of the Gray herbarium he was enabled to examine Asa Gray's types of *Metrosideros rugosa,* and varieties of *Metrosideros collina* subspec. *polymorpha* (previously known as *Metrosideros polymorpha* Gaud.) The writer had at his disposal for examination also specimens of *Metrosideros collina* (Forster) Gray from the South Sea Islands, as Fiji and Tahiti, as well as specimens from the Kermadec Islands. The writer is indebted to Dr. T. F. Cheeseman for specimens collected in the latter islands.

INTRODUCTION

During the years 1741 to 1755 there appeared a work by George Eberhard Rumpf in six volumes entitled *"Herbarium Amboinense."*

His name has been latinized to Rumphius and his work is now usually quoted as Rumphius, Herbarium Amboinense.

It is in this work that the name *Metrosideros* appears for the first time. The genus *Metrosideros* was published in Book Four, (heft) pamphlet six, on page 19, and the first specimen described under *Metrosideros* is figured on table seven.*

Rumphius figures and describes under the name of *Metrosideros* other plants which belong to five different families. The first is *Metrosideros vera* on plate seven of which Rumphius remarks as follows:

"Ramum exhibet at Litt. A. floriferum arboris, quae Metrosideros vera seu Nani vocatur.

Observatio

Arbor-haec sub nomine *Nani* a Valent. in Aboinae descripsit page 220 occurrit et in Tab. sub no, LIII, exhibetur."†

Other specimens figured as *Metrosideros* by Rumphius are:

T. 8 Metrosideros macassarensis
" 9 Nani hua
" 10 Metrosideros Amboinensis
" 11 Metrosideros molucca
" 12 Metrosideri quae Samar femina vocatur=?—
(two pictures A and B.)
" 13 Metrosideros spuria

None of the above cited plants belong to the family *Myrtaceae* to which his first species *Metrosideros vera* belongs.

In the year 1763 there appeared Michel Adanson's work Familles des Plantes. Adanson takes up the name *Nani* instead of *Metrosideros* and on page 88 in Volume II gives the following short description:—

"Feulles opp. fleurs, terminal corymbs. calyce 4 egales, corolle 4. Etamine 50. Fruit baye graines—plusieures osselets dans chaque loge."

This is all Adanson has to say in regard to *Nani;* he gives no citation nor does he connect any definite plant with the name *Nani.* He evidently refers to *Nani=Metrosideros vera* as the description would indicate.

This name *Nani* was latinized by Frederic A. W. Miquel to *Nania* in his Flora Indiae batavae (1885, page 399, Part I.) Miquel gives the first proper description of the genus *Nania* (*Nani*) and cites the following specimen:—

Nania vera Miq. mss.—*Metrosideros vera* minor Rumph. Herb. Am. III. p. 16 t. 7 — *Syncarpia Vertholeni* Teysm. et Binnend. Natuurk. Tijdschr. Neerl. Ind. II, p. 307.

---

* Proper citation for **Metrosideros vera** is: Rumphius Herbarium Amboinense III: 19. t. 7. 1743.
† Translation: This tree is mentioned by Valent. in his description of Amboina and called by him Nani Tree and figured on plate 53.

Previous to Miquel's publication of *Nania vera* in his Flora Indiae batavae, J. E. Theysmann and S. Binnendijk published a paper entitled Nieuwe Plantensorten in's Lands Plantentiun Te Buitenzorg, in Natuurkundig Tijdschrift voor Ned. Ind. Vol. II: 307. 1851. In that paper appears a description of a plant under the name *Syncarpia Vertholeni* as follows:

Syncarpia Vertholeni nobis.

"This is the tree which is figured in Herbar. Amboin. by Rumphius, Vol. III, page 16, t 7, and described under the name of **Metrosideros vera.**"

He states further that young plants had been brought from Amboina to Buitenzorg where it fruited profusely; it became evident that it did not belong to *Metrosideros* which had been established by Banks, but to *Syncarpia,* etc.

The specific name *Vertholeni* was given in honor of Lieutenant Colonel Vertholen.

The name *Metrosideros vera* Rumph has however no validity as it is pre-Linnean (ante 1753).

John Lindley in his Collectanea Botanica or figures and botanical illustrations of rare and curious exotic plants, figures on plate 18 (1821) *Metrosideros vera* which is the legal publication of the specific name *vera.* The name *vera* was however not taken up by Teysmann and Binnendijk who subsituted the name *Vertholeni* but the plant was placed by them in the genus *Syncarpia,* which was erroneous.

If the plant published on plate 18 by Lindley is really identical with Rumphius' *Metrosideros vera* and if the publication of a plate is sufficient to establish authorship, then the proper name for the plant in question is *Nania vera* (Lindley) Miquel. If the opposite is the case then the plant must bear the name *Nania Vertholeni* (Teysmann and Binnendijk) Rock. The genus *Nania* is not a synonym of *Metrosideros* but is a distinct genus as has been pointed out by Drs. Koorders and Valeton, who published a second species of *Nania, N. petiolata* and who consequently upheld *Nania vera* (Lindley) Miquel.

The capsule of *Nania* is—*4—loculare, loculicida demum tota libera, calyce recurvo suffulta.* (The capsule is four celled and entirely free from the recurved calyx.)

The writer has seen and examined abundant material of *Nania vera* as well as of *Nania petiolata* in the Herbarium of the Botanical Gardens at Buitenzorg in Java. He also examined a living tree of *Nania vera* in the above mentioned gardens and is of the same opinion as Drs. Koorders and Valeton. *Nania* is certainly generically distinct from *Metrosideros,* the habit also is not that of a true *Metrosideros.*

NOMENCLATURE OF THE GENUS **METROSIDEROS**, ITS HISTORY, AND THE TAXONOMY OF **METROSIDEROS COLLINA** THE TYPE OF THE GENUS

Since the genus *Nania,* based on *Nania vera* must be eliminated from *Metrosideros* and recognized as a distinct genus of two species, the former and *Nania petiolata,* we must look for another species as the type of the genus *Metrosideros.*

The genus *Metrosideros* was established by Joseph Banks in Joseph Gaertner's de Fructibus et seminibus plantarum published in the first volume on page 170 and based on twelve species which are figured on table 34; the volume appeared in 1788. The twelve species are of Solander. Only four out of the twelve species are true *Metrosideros;* the remaining eight have been referred to other genera.

The status of the twelve species is as follows:

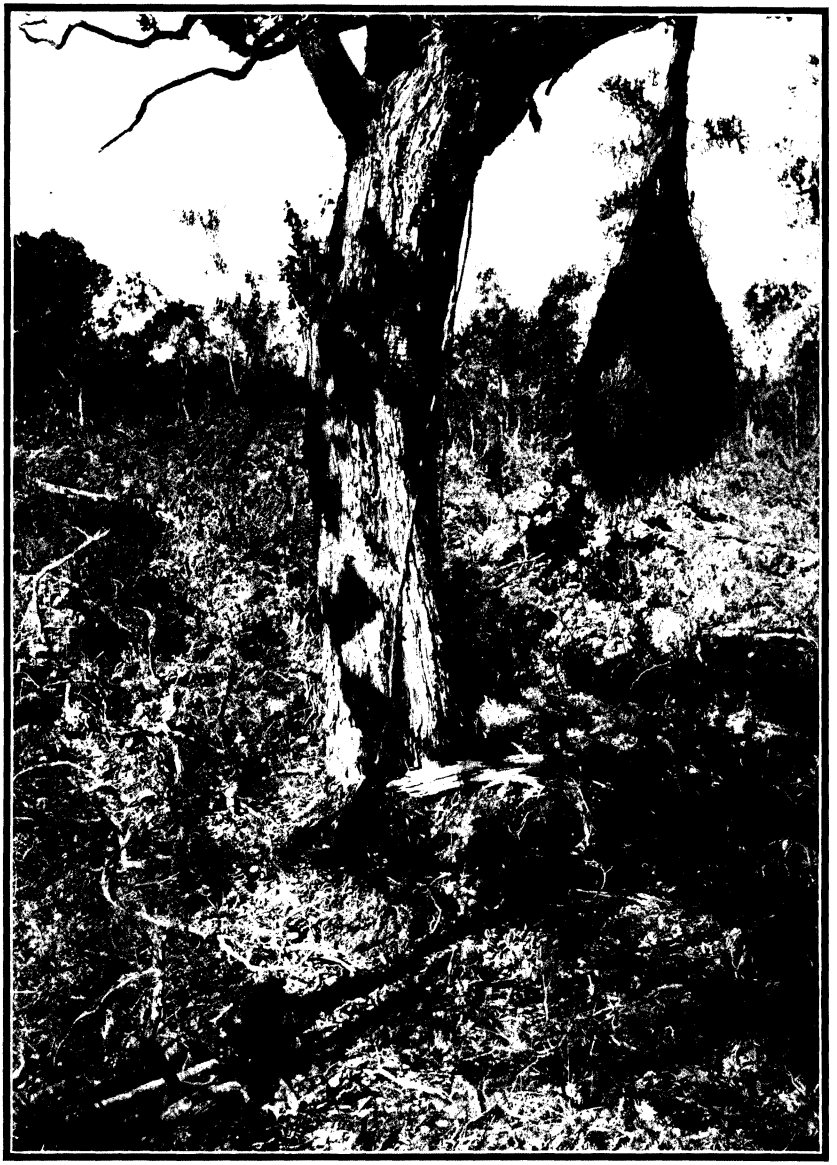
1 Metrosideros gummifera Sol.=Eucalyptus gummifera (Banks) Sm.= Eucalyptus corymbosa teste Ind. Kew.
2. " costata Sol.=Angophora lanceolata Sm.
3. " salicifolia Sol.=Eucalyptus sp?
4. " viminalis Sol.=Callistemon rigidus
5. " armillaris Sol.=Melaleuca armillaris
6. " nodosa Sol.=Melaleuca nodosa
7. " fulgens Sol.=Angophora lanceolata Sm.
8. " excelsa Sol.=Leptospermum sp?
9. " spectabilis Sol. = Leptospermum collinum J. Forster = Melaleuca villosa L. f.=Melaleuca sp? G. Forster= Melaleuca aestuosa G. Forster=Metrosideros villosa (L. f.) Smith=Metrosideros collina (Forster) Gray.
10. " scandens Sol.
" albiflora Sol.
" myrtifolia Sol.=Metrosideros diffusa (G. Forster) Smith.

Since the ninth species, *M. spectabilis* is the first true *Metrosideros* it is here adopted as the type of the genus. However the specific name *collinum* being the first valid specific name published in the combination with *Leptospermum* which is identical with No. nine of Banks and Solander, the proper combination is therefore *Metrosideros collina* (Forster) Gray U. S. E. E. 1854, and not *Metrosideros villosa* (L. f.) Smith Bot. Charact. 1797.

James Edward Smith in his "Botanical Characters of some plants of the natural order of Myrti" in the Transactions of the Linnean Society of London, Vol. III, 268, 1797, publishes an article on the existing confusion of the genus *Metrosideros* and in an effort to straighten out the species of Linnaeus the younger and George Forster, makes the following statement:

"That this is a most distinct natural genus from **Leptospermum** as above defined there can be no doubt, though some great botanists have united them. Sir Joseph Banks, however, and Dr. Solander were well aware of their difference, and characterized **Metrosideros** by its very long stamina. The stigma being simple and small, not

PLATE I.



Metrosideros tree (var. **incana**) showing large bunch of aerial roots. Growing on the Lava flows of Kona, Hawaii.

capitate nor depressed scarcely dilated, I beg leave to propose as a very certain and constant mark of distinction. The habit, moreover, is totally different from **Leptospermum,** and agrees with that of **Melaleuca;** at least this is the case with such species as have alternate leaves and those with opposite ones have no resemblance to **Leptospermum.**

"The petals are concave, nearly sessile, deciduous, generally less colored than the stamina. The capsule has most generally 3 valves and as many cells rarely 4. I believe it might safely be defined trilocularis absolutely, but I mentioned the number four in deference to Gaertner, till I can determine and examine all his species, which are very obscure. His **gummifera** is an **Eucalyptus** and some of his others are very doubtful. The species of this genus, described as **Melaleuca** by the younger Linnaeus and Dr. George Forster, are also very much confused, these authors having mutually misunderstood each other so often, and formed their definitions so loosely that, with most of their original named specimens before me, I can hardly clear up every doubt; nor can I at present determine how many of Forster's species are among Gaertner's."

He then enumerates 13 species under *Metrosideros* of which however only four are true *Metrosideros*, the other nine being distributed among the genera *Angophora, Syncarpia, Callistemon* and *Kunzea.*

George Forster in his Prodromus Florulae Insularum Australium published in 1786, enumerates and describes 9 species of *Melaleuca* on page 38, as follows:

Number 210—Melaleuca scoparia=Leptospermum scoparium
Number 211—Melaleuca virgata=Baeckea virgata
Number 212—Melaleuca perforata=Metrosideros perforata
Number 213—Melaleuca diffusa=Metrosideros diffusa.
Number 214—Melaleuca florida=Metrosideros diffusa
Number 215—Melaleuca aestuosa, foliis oppositis ovatis, ovatisque venosis (subtrinervis), pedunculis cymosis terminalibus tomentosis. F. Leptosperum collinum Forster Charact. gen. 36. No. 2= Metrosideros collina (F.) Gray. Melaleuca lucida? M. S. V. p. 699 No. 2 Societatis insulae
Number 216—Melaleuca lucida=Metrosideros lucida
Number 217—Melaleuca ciliata=Metrosideros ciliata
Number 218—Melaleuca Leucadendron=Melaleuca leucadendron

Of his nine species only one, as can be seen by the determination, is a true *Melaleuca,* six belong to *Metrosideros.* The Index Kewensis is very faulty in regard to the above mentioned species for example: Index Kew II, page 187, *Melaleuca florida* G. Forst. is quoted as a synonym of *Metrosideros diffusa* (G. Forst.) Smith; on page 221 *Metrosideros florida* (G. Forst.) Smith which is *Melaleuca florida* G. Forst. is upheld as a good species. It may be that George Forster united two distinct species under *Melaleuca florida,* but why is it not annotated by the usual "in part"?

Again, Index Kew. II, page 188, *Melaleuca villosa* L. f. 1781 is upheld as a good species from Tahiti, while on page 222 it is quoted as a synonym of *Metrosideros villosa* (L. f.) Smith, and on page 64 *Leptospermum collinum* F. 1776 is equal to *Metrosideros collina* (F.) Gray which is upheld as a good species, while on page 221 it is quoted as a synonym of *Metrosideros villosa* (L. f.) Sm.

Such citation can only lead to confusion.

The synonymy of *Metrosideros collina* (J. R. Forster) Asa Gray is as follows:

PLATE II.

Metrosideros collina (F.) A. Gray subspec. **polymorpha** (Gaud.) var. **incana** (Levl.) growing epiphytically on **Sadleria cyatheoides** on the 1907 aa lava flow. South Kona, Hawaii.

Metrosideros collina (Forster) Asa Gray, United States Exploring Expedition Vol. XIV: 558 t. 68. 1854.

Leptospermum collinum J. R. Forster Charact. gen. Plant. 72. 1776.

Melaleuca villosa Linn. f. Supplement 342. 1781.

Melaleuca aestuosa G. Forster Florul. Ins. Austr. Prodr. 38, No. 215. 1786.

Melaleuca sp.? G. Forster. 1786.

Metrosideros spectabilis Banks et Solander ex Gaertner de Fruct. Semin. Plant. Vol. I. 170, t. 34. 1788.

Metrosideros villosa (L. f.) Smith Transact. Linn. Soc. Vol. III:268. 1797.

Charles Gaudichaud-Beaupré, the Botanist of the *"Voyage autour du mond sur la corvete l'Uranie,"* published in the year 1826 a *Metrosideros polymorpha* from the Hawaiian Islands, remarking in the introduction on page 99 of the above cited publication: "Rien au monde, en effet, n'est plus remarquable que le *metrosideros polymorpha,* à feuilles linéaires vers le sommet de la montagne, successivement linéaires — lancéolées, lancéolées ovales, obovales, elliptiques, arrondis, meme cordiformes, a mesure qu'on en descend, et qui, de glabres et luisantes qu'elles étoient primitivement, deviement pubescentes, velues, et de plus en plus tomenteuse."

Asa Gray, who worked up the material collected by the U. S. Exploring Expedition under Capt. Wilkes, established in Volume 14 of the U. S. E. E., 1854, page 558 ,for the first time the proper combination using the oldest name *collinum* of Forster, *Metrosideros collina* (Forster) Asa Gray, at the same time establishing three varieties of the latter, var. *α villosa* citing *Melaleuca villosa, Metrosideros spectabilis* and *Metrosideros villosa* Smith, as synonyms; var. *βglaberrima* citing *Metrosideros villosa* var. *glaberrima* Bertero ex Guill. Zeph. Tait. page 57, and *Metrosideros diffusa* Hooker et Arnott as synonyms, and a variety *γ viticnsis* v. n.

He further remarks: "The *M. villosa* of Smith with the young leaves, branchlets and especially the inflorescence canescent with a villous-tomentose down, passes so completely into glabrate and truly glabrous forms that it becomes advisable to restore the earliest specific name, that of the elder Forster."

Asa Gray, however, recognizes also *Metrosideros polymorpha* of Gaudichaud mainly on the strength of the pedicellate flowers, while those of *M. collina* are sessile, or, as he remarks himself, "nearly so." From the specimens in the Gray Herbarium, which were kindly put at my disposal as a loan through the courtesy of Dr. B. L. Robinson of Harvard, I could see that the pedicellate flowers as a specific distinction between *M. collina* and *M. polymorpha* are untenable. For in the various specimens of *M. collina* from Tahiti, Fiji and Society Islands, there are sessile as well as pedicellate flowers noticeable, in fact, in some specimens, the pedicels were even longer than occur in *M. polymorpha.* Hillebrand himself, in his "Flora of the Hawaiian Islands," remarks in a footnote: "Having already convinced myself from an examination in the Gray Herbarium that forms of *M. collina* from the Society and Viti groups were in no particular distinguishable from var. *ζ* * of the Hawaiian *M. polymorpha,* I

* Now: **Metrosideros tremuloides** (Heller) Knuth.

PLATE III.

A tall **metrosideros** tree with stilt roots, caused by germinating and beginning life at the top of a tree fern. Remnants of the supporting fern can still be seen in the middle of the trunk. The prevailing type in the rain forest near Glenwood, Hawaii.

readily adopt the view of B. Seeman, who, after a review of the larger material preserved in the British Museum, comes to the conclusion that all the *Metrosideros* of those groups belong to the Hawaiian polymorphous species." It would be convenient indeed, if the specific name *polymorpha* could be retained, were it not for the laws of nomenclature and priority, which force us to accept the earliest name which is Forster's *collina*. But owing to the very few variations occurring in the species *collina* in the South Sea Islands, and the large number of varieties and forms found in the Hawaiian Islands, which in themselves vary again tremendously, the writer was prompted to adopt for the Hawaiian forms the specific name *polymorpha*, of Gaudichaud, as a subspecific one of *Metrosideros collina* (Forster) A. Gray. This is done for two main reasons, first, to designate the Hawaiian forms; and second, to avoid too much confusion in nomenclature and synonymy.

The writer was loath to establish this trinominal system for our Hawaiian *Metrosideros*, but found that it is the least objectionable, for reasons above stated.

Outside the four endemic species of *Metrosideros*, all the remaining varieties and forms treated in this paper must then be referred to *Metrosideros collina* (J. R. Forster) Asa Gray, subspecies *polymorpha* (Gaudichaud) Rock.

Niedenzu* quotes Forster as the author of *Metrosideros polymorpha* instead of Gaudichaud; how he came to commit this error is difficult to see, since Forster has never been quoted as author of *M. polymorpha*, save by T. Kirk in his "Forest Flora of New Zealand," which gives Forster as the author of *polymorpha*, but does not cite the bibliography, or on what authority he based his combination.

POSITION OF THE GENUS METROSIDEROS, ITS SECTIONS AND SPECIES ACCORDING TO OUR PRESENT KNOWLEDGE

Niedenzu, in his treatment on the Myrtaceae in Engler and Prantl,* places the genus *Metrosideros* Banks, at the head of the section *Leptospermoideae-Metrosiderineae*. According to Niedenzu a species of plant possessing the following characters, is referable to the genus *Metrosideros:*

"Corolla perigynous. Receptaculum turbinate, campanulate or urceolate. Calyx lobes 5, broad, obtuse. Corolla lobes 5, rounded. Stamens many, usually in one row; filaments free, long; anthers elongate, dorsifixed, versatil, with longitudinal cells; connective with glandular point. Ovary united with the receptaculum at the base, three-celled; style very long; stigma simple. Placenta axile; ovules covering the whole placenta, ascending. Seeds many only partly fertile; testa thin; embryo straight; cotyledons flat or folded, longer than hypocotyle. Trees or shrubs, rarely climbers. Leaves opposite. Flowers in terminal—rarely axillary cymes."

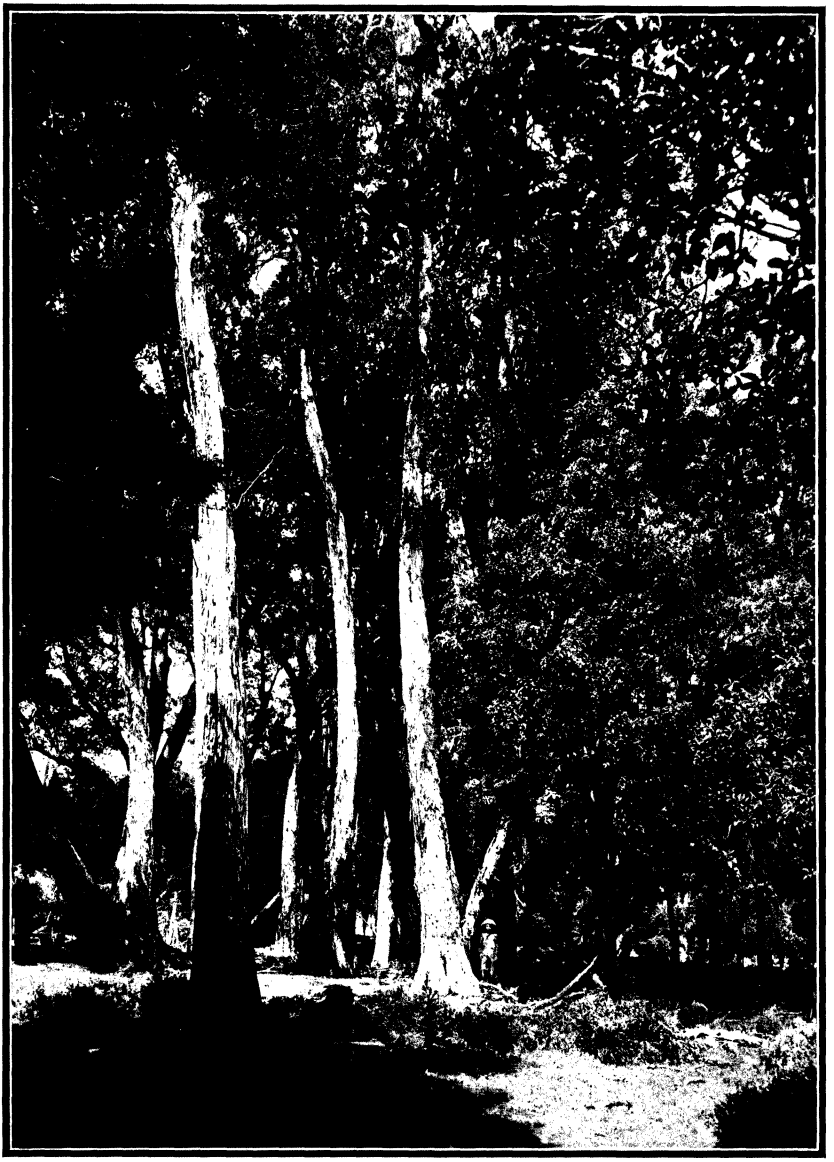
He divides the genus into two sections based on the shape of the seeds, as follows:

Section one:—*Eumetrosideros* Ndz. Seeds linear.

Section two:—*Nania* Miq. Seeds flattened.

* Engler and Prantl Naturliche Pflanzenfam. III: 7. 87. 1893.

PLATE IV.



Metrosideros collina polymorpha var **incana.**

A grove of mature trees in the Kipuka Puaulu, near the Volcano of Kilauea, on Hawaii. The trees are over 80 feet in height, some of them nearly a hundred feet.

The first section is divided into two groups: *A*—capsule exserted from the receptaculum, and *B*—capsule enclosed in the receptaculum.

This seems to be untenable, as we find capsules both enclosed and exserted, in the numerous varieties and forms of *M. collina* (F.) Gray subsp. *polymorpha* (Gaud.); thus eliminating it as a key for the species. Section two is eliminated entirely as it embraces *Nania vera* which is not referable to *Metrosideros*.

Characters for specific distinction

As already remarked in the previous chapter, Niedenzu's key based on the enclosed and exserted capsules is untenable, as such characters occur in the varieties and forms of one species. It is difficult indeed to designate real and sound specific characters, at least as far as the Hawaiian species are concerned, for strictly speaking there is but one real good species to be found in these islands outside *M. collina* subsp. *polymorpha*, and that is *M. macropus* H. et A. While *M. rugosa, M. tremuloides,* and *M. Waialealae* are certainly different from *M. collina* when seen growing in the field, they appear, after close investigation, to be nothing else than ancient satellites of *M. collina*, and perhaps referable to that species. They are indeed very old varieties at least, for they are constant and quite distinct and show no such gradation in leaf characters as are found in varieties and even forms of *M. collina* subsp. *polymorpha*. Var. *incana*, for example, displaying not less than fourteen different grades, all referable to this one variety, while forma *sericea* of the var. *glaberrima* displays six different gradations, and the variety proper, seven and even more, for there are still others which must be referred to this variety and form. The writer thought it advisable to uphold the specific rank of the three otherwise doubtful species on the fact that their characters are constant, and that they, themselves, are confined to one island, not having been found on more than one, and at that are restricted to a very circumscribed locality.

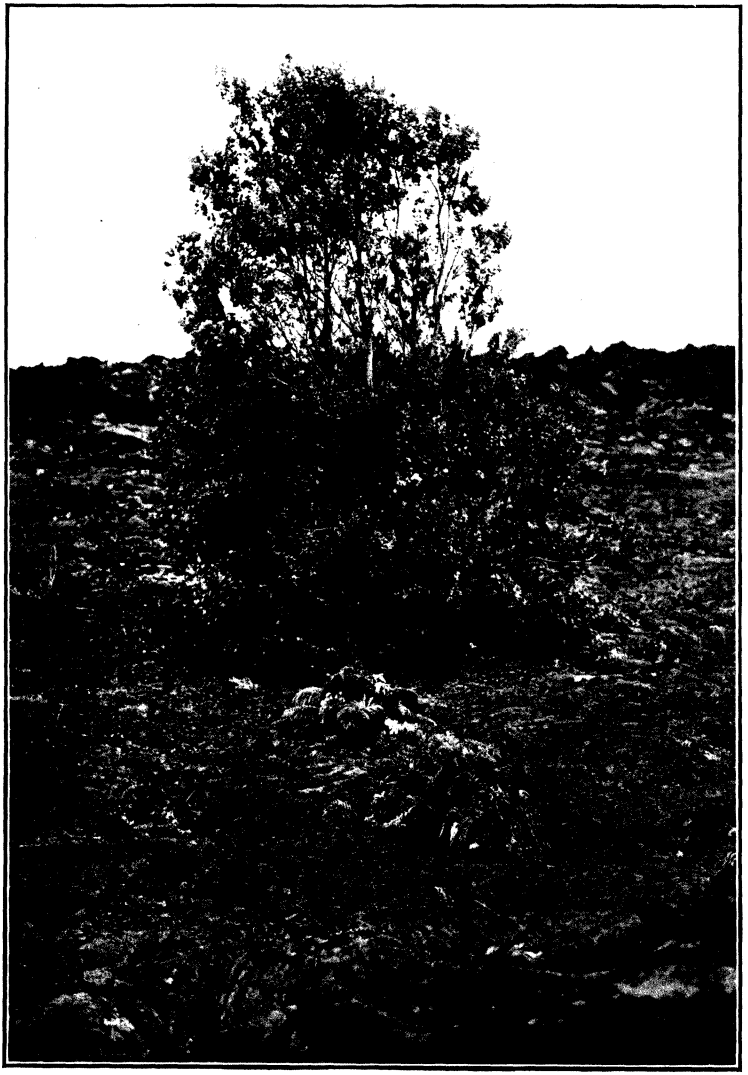
M. Macropus is the most distinct of all of the Hawaiian species, and is distinguishable by its very long petioled leaves and the open but densely bracteate and bracteolate cyme.

M. tremuloides is distinguished by its very slender graceful foliage, and drooping flexible branchlets; closely related to it is *M. Waialealae*, which as the specific name implies, inhabits the high swampy plateau of Kauai, Mt. Waialeale, 5000 feet, where it is a handsome tree, perfectly glabrous in all parts, its leaves are of a pale green with red midrib and veins, are long petioled, and caudately acuminate.

M. rugosa inhabits only the open, exposed cliffs on the very crest of the main back-bone of the Island of Oahu, overlooking the windward side. It is distinguished by its thick, coriaceous, deeply rugose leaves, which are dark green above and densely woolly underneath. It is nearly always a shrub, very seldom becoming a small tree 10-15 feet in height.

In separating the numerous varieties and forms of *Metrosideros collina* subspecies *polymorpha*, the following characters have been selected: First the writer adopted Gaudichaud's type of *M. polymorpha*, as figured in Plate 108 in the Atlas of the Botany Voyage Uranie, as the typical form, accepting Gaudichaud's name *polymorpha* as a subspecific name in order to designate the

PLATE V.



Metrosideros collina (F.) A. Gray subspec. **polymorpha** (Gaud.) var. **incana** (Levl.) growing on the 1868 pahoehoe (smooth) lava flow. It started life in all probability on such **Sadleria** ferns as are seen in the foreground.

Hawaiian varieties of *M. collina,* and making Gaudichaud's type the var. *α typica.* Var. *imbricata* which occurs only on Oahu, differs from *α typica* in the thinner leaves, which are subsessile and imbricately arranged on the branches; some authors say that this may be due to dry seasons, when growth has been checked. This is very questionable for the plate shows three specimens collected at intervals of two or even three decades, and the characteristic imbrication is present in all three specimens. Besides specimens collected by the writer fifty years after the last specimen collected by Seeman (the middle figure on Plate XVII), show the same characteristics.

The other characters which served for the separating of varieties are as follows: 1. Leaves densely tomentose, as well as inflorescence. 2. Leaves small thick, ovate, subsessile, perfectly glabrous, but woolly inflorescence. 3. Leaves very large, fleshy ovate-oblong petiolate, glabrous, inflorescence tomentose. 4. Leaves smaller, linear-oblong, perfectly glabrous, woolly inflorescence. 5. Plant a bush 3 feet high, with ovate glabrous leaves acute at both ends, inflorescence woolly. 6. Leaves very small, cordate, plant small prostrate only a few inches long, inflorescence woolly. 7. Leaves linear, almost lanceolate, glabrous, inflorescenc pruinose. 8. Leaves and inflorescence perfectly glabrous.

While the writer does not at all claim the present arrangement or key to these varieties to be the last word, it nevertheless places these varieties and their forms according to their relationship to one another. Hybridization has probably been the main factor, next to location and environment, in producing these varieties. While a number of them are constant, others embrace a host of variations, which, if one were to undertake to name, would mean the naming of each individual tree he comes across.

Phylogeny of the Hawaiian Metrosideros

It is difficult indeed to point to a certain species as ancestor of the Hawaiian *Metrosideros.* It may be assumed, however, that all the species of *Metrosideros* known outside of these Islands, were not evolved from species occurring in the Hawaiian Islands, but that exactly the reverse is the case.

Metrosideros collina (Forster) A. Gray, which is so widely distributed over the South Pacific Islands, must undoubtedly have originated in that region, perhaps was evolved from some of the monotypic genera still existing in South America, so rich in *Myrtaceae.* Nowhere in the South Pacific Islands has *Metrosideros collina* split into so numerous varieties and forms as in the Hawaiian Islands. The typical *Metrosideros collina* of Fiji is identical with specimens of the same species from Tahiti and the Kermadec Islands, while in Hawaii there is not one variety of which it could be said with the same accuracy, that it is absolutely identical with the typical *M. collina,* of the South Seas, however close to and inseparable it may be from the typical *M. collina.* This fact resolved the writer to adopt the old specific name *polymorpha* as subspecies name. The Hawaiian var. *incana* is the nearest to the typical *M. collina* of Tahiti and Fiji, while the Hawaiian var. *glaberrima* forma *sericea* is almost identical with Asa Gray's var. *γ viticnsis* from Fiji.

In none of the South Sea forms do we find as long petiolate leaves as in the Hawaiian forms, which fact may be due to the infusion of blood from the very distinct species *M. macropus* H. et A. peculiar to Oahu (?). The presence of

PLATE VI.

Typical Tree-fern forest at Kilauea, Hawaii; the forest is of the younger type and is composed mainly of **Cibotium Chammissoi, C. Menziesii** and **Metrosideros collina polymorpha** var. **incana.**

this species and the numerous types of topography, as from sea level to almost perpetual snow, and the influence of climatic differences, are the probable factors responsible for the numerous varieties.

The characters which we now recognize as attributable to the genus *Metrosideros,* were undoubtedly established on the old island of New Zealand, which became the center of distribution after the emergence of the islands of the South and North Pacific. New Zealand possesses the largest number of endemic species, from large trees to actual lianas or climbers. *Metrosideros collina* is also present in New Zealand, but is absent from Norfolk Island and from Australia. As far as the colony of New Zealand is concerned, it is confined to Sunday Island, one of the Kermadec group.

That *Metrosideros collina,* which developed into the subspecies *polymorpha,* due to facts already stated, is a comparatively speaking new arrival in the Hawaiian group, of course by far antedating the arrival of the race which we call Hawaiians, is well illustrated by its distribution on the large island Hawaii, where it forms almost pure stands over large tracts of land. There it is the prevailing tree, while on the much older islands as Kauai, Oahu and Molokai, it occurs never in pure stands, but always as individuals, which increase in number wherever man has disturbed conditions, as in the outskirts of the forest on the lee side of Kauai, where vegetation, which is less able to quickly establish itself again, is kept down by the upgrowth of *Metrosideros.* Were *Metrosideros collina* as old an inhabitant as some of the other Hawaiian trees, for example the *Kalia, Elaeocarpus bifidus,* which takes the places of *Metrosideros collina* in the middle forest region on Kauai, it would certainly cover the older islands to the same extent as it covers the large island Hawaii today. For if any tree can adapt itself to almost any condition and environment, it is the *Ohia Lehua, Metrosideros collina polymorpha.*

The Hawaiian *Metrosideros collina polymorpha,* especially the varieties occurring on the Island of Hawaii, develop often large bunches of aerial roots, not only in dry regions where only a xerophytic vegetation can thrive, but also in the most humid rain forests. This proves that the developing of aerial roots is not for assimilating purposes, such as for taking up moisture from the air, etc., but that their presence is due to a law of heredity, the reverting to, or the producing of certain characters peculiar to the ancestor. This ancestor may be found in some of the climbing species of New Zealand, probably the oldest forms in the genus *Metrosideros.* Mr. Chesemann informs the writer that the *Metrosideros robusta* of New Zealand develops huge aerial roots, which coalesce and form large trunks. Such aerial roots as occur in *Metrosideros robusta* seem not to be the same as those referred to, for Mr. Chesemann says in his "Flora of New Zealand": "It usually begins life as an epiphyte in the upper branches of some tall forest tree, sending to the ground aerial roots which coalesce and form a trunk after the death of the supporting plant." Exactly the same happens with our subspecies *polymorpha,* which even commences life as an epiphyte on the arid lava flows on small ferns, which always precede a stand of *Ohia* trees on newer lava flows.

The aerial roots the writer refers to do not, at least he has been unable to observe it, coalesce and form trunks, but grow out of the upper branches of often very tall trees, and have the aspect of a huge weaver-bird's nest.

PLATE VII.

Typical **Metrosideros** forest, the prevailing type is the variety **incana.** **Cibotium** ferns in foreground.

The Hawaiian *Metrosideros,* at least *M. collina polymorpha,* begins life as an epiphyte even on new lava flows, as the accompanying plate illustrates. (On the 1907 flow on the slopes of Mauna Loa, the first Ohia lehua beginning life as an epiphyte on *Sadleria cyatheoides,* the *Amau* fern.) In the somber forests it begins life more often on *Cibotium menziesii* and *Cibotium chamissoi,* the *Hapu iii* and *Hapu* tree ferns, respectively, than as a terestrial. What happens in New Zealand with *M. robusta* repeats itself with *M. collina polymorpha,* especially the var. *incana,* only that the supporter in Hawaii succumbs more quickly than the big tree in New Zealand; as the tree fern is of much smaller stature the Ohia lehua cannot develop such huge trunks as the New Zealand *Rata.*

Distribution of the genus Metrosideros

As has been stated in the previous chapter, the home of the genus *Metrosideros* is probably to be found in New Zealand; for the largest number of endemic species occur there.

In the latest work on the "Flora of New Zealand" Cheeseman enumerates and describes eleven species, ten of which are endemic, while one is distributed all over Polynesia. Of the ten endemic species, four are actual climbers, while two are climbing shrubs, one a much branched shrub with straggling, often prostrate branches, and the remaining three, trees reaching a height of from 30-60, or in one case (*M. robusta*) even 100 feet. In the Polynesian Islands the genus is represented by *Metrosideros collina,* extending from the Kermadec Islands to Hawaii, where it is represented by the subspecies *polymorpha,* over a latitude of from about 30° South to 22° North. One species, *M. angustifolia,* is peculiar to South Africa.

Metrosideros lucida extends the farthest south of any, reaching a latitude of 52° S. in Auckland Island, where it is abundant from sea level to an elevation of 500 feet, skirting the eastern shore with a broad belt of forest; it reaches a height of 20-40 feet, with a trunk of 2-3 feet in diameter.

In the Hawaiian Islands the genus is represented, next to the common *M. collina polymorpha* with its many varieties, by four species, one of which is very distinct, while the three others are more or less intimately connected with *M. collina polymorpha.* In North Australia we find a lone species of *Metrosideros, M. eucalyptoides,* growing in arid regions, and in New Caledonia several species peculiar to that island.

Distribution of Metrosideros collina (Forst.) A. Gray.

Metrosideros collina is the only species of the genus which enjoys a distribution covering a latitude from about 30° S. to 22° N. Its southernmost station is on Raoul or Sunday Island of the Kermadec group, latitude 29° 20′ S., where it can be found from sea level to the summit of the island, 1627 feet elevation. According to Chesemann it is the most abundant tree.

In the Society Islands it has been collected on Tahiti where it grows from practically sea level to 3600 feet elevation, and on Eimeo Island of the same group, extending from there to the Marquesas Islands, where it was collected on Noukahiva by Dupetit-Thouars, Mercier, Hombran and Jardin; and to Mangareva of the Paumotu Archipelago.

In Rarotonga, the chief island of the Cook group, it is abundant on all the hills ascending to the tops of the highest peaks, altitude 2200 feet. Chesemann

Fern and **Metrosideros** forest back of the Shipman Ranch on the trail to Puu Oo. The trees are var. **incana** of **Metrosideros,** the ferns **Cibotium Menziesii** and **C. Chamissoi.**

states that the tomentose form is much more plentiful than a nearly glabrous form with broader leaves.

In the Fiji or Viti Islands it is not uncommon on the Islands of Ovolau and Muthuata from an elevation of 100 to 2000 feet. In Samoa it has been observed by Reinecke on Tutuila at an elevation of 2000 feet. New Caledonia seems to be the western limit of its distribution, being found in about 166° E. Long., and Mangarewa, its easternmost at about 134° W. Long.

Its northernmost limit is reached in the Hawaiian group, where it is represented by the subspecies *polymorpha* with numerous varieties and forms, the distribution of which over the group proper is described in the following chapter.

DISTRIBUTION OF THE SPECIES AND VARIETIES OF METROSIDEROS IN THE HAWAIIAN ISLANDS

Besides the many varieties and forms of *M. collina polymorpha* which are more or less widely distributed over the whole group, there are four species which are rather local, that is they occur only in circumscribed localities. This, however, may be also said of certain varieties of *M. collina polymorpha*, and thus the question arises if three of the four species, which, like certain varieties of the species above mentioned, are constant, should not be referred to *M. collina polymorpha*, as has been done by earlier systematists. Certain points arise, however, which bear investigation, for example:

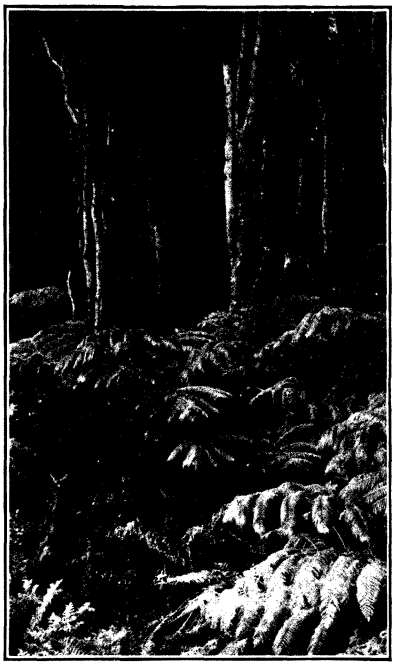
Metrosideros waialealae and *Metrosideros collina polymorpha* var. *prostrata*.

Both of these plants occur in the bog on the summit of Mt. Waialeale on Kauai, at an elevation of 5200 feet. The former species, a very handsome, if not the finest species of *Metrosideros* in these Islands, is a tree 25 feet in height, while only a few yards from it grows another *Metrosideros* referable to *M. collina polymorpha*, which, as the varietal name (*prostrata*) indicates, is a little creeping plant a foot or so in length. This same variety occurs on West Maui and Molokai, and a form of it in the bogs of the Kohala Mountains on Hawaii. *M. waialealae*, however, is peculiar to Mt. Waialeale on Kauai and while in its outward aspect quite different from *M. collina polymorpha* is, when closely examined, referable to the very glabrous varieties of that species; nevertheless, the caudately acuminate and long petioled leaves and very large flowers and fruits seem to justify its being raised to specific rank. Its specific value seems to be strengthened by the fact that when *M. collina polymorpha* encroaches on the various bogs of the Islands, it always becomes a creeper, while *M. waialealae* is a tree.

The second somewhat doubtful species is *M. tremuloides;* this, too, would come under the small leaved, glabrous varieties of *M. collina polymorpha*. Its outward aspect, the very slender graceful foliage and slender drooping branches and branchlets, distinguish this tree at once from all other species or varieties of *M. collina polymorpha*. It is confined to the Island of Oahu, occurring on the main range, especially at the lower elevations up to 2000 feet, mainly in the valleys, as in Kalihi, Nuuanu, Panoa, Manoa, Palolo, and Niu. It usually grows by itself, but can often be found in company with var. *a* typica of *M. collina polymorpha*, and also var. *glaberrima*. Other writers, enlarging the characters of this species, have recorded it from other islands, but these types must be referred to varieties of *M. collina polymorpha*.

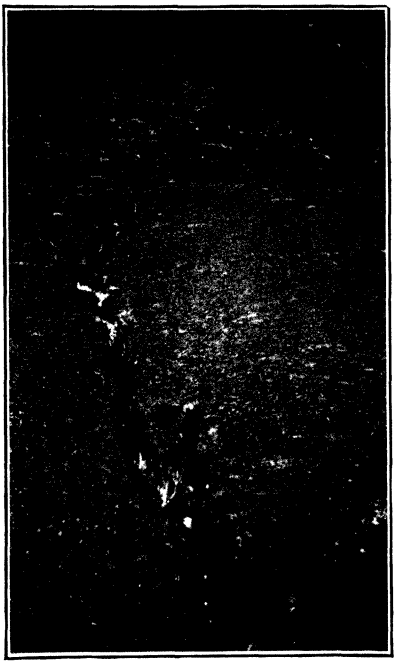
PLATE IX.

a



Pure stand of **Metrosideros collina polymorpha** var. **incana** along the road to the Volcano Kilauea. **Cibotium Menziesii** and **C. Chamissoi** form the main undergrowth.

b



Metrosideros collina polymorpha var. **incana** starting life in the cracks of the solid (pahoehoe) smooth lava floor of the crater Keanakakoi on Hawaii.

c

Metrosideros collina polymorpha var. **incana** growing on the 1823 **aa** rough lava flow along the Kau Road, Hawaii.

The third is a small tree usually stunted and as its name implies, quite rugose. *M. rugosa* established by Gray, was also classified with varieties of *M. Polymorpha=M. collina polymorpha.* Its very deeply rugose, woolly leaves and yellow scales and buds, and the gnarled habit of the small tree distinguishes it from the other *Ohia lehuas,* which, as Heller remarks, were even recognized by the Hawaiians, who were good botanists in their way, and gave them all specific names. This species for instance, they knew under the name of *Lehua papa.* It occurs only on the Island of Oahu, and that mainly on the very crest of the main range overlooking the windswept palis or cliffs on the windward side of the Island. It is a small tree or shrub, growing in company with *Coreopsis* and *Dubautia,* both composites, *Lobelia* and *Trematolobelia,* as well as with sedges, as *Cladium Meyenii* and *Cl. angustifolium.* It does occur, however, as a small tree 15 feet high, but still on exposed windswept locations in the mountains of Punaluu. It comes close to the form of *a typica* of *M. collina polymorpha,* found on Oahu, with which it is occasionally confused by the layman, but the difference is quite apparent when the two plants are placed side by side.

When one compares the three aforementioned species with one another, one cannot but come to the conclusion that they represent three distinct species, but when they are being compared with certain varieties of *M. collina polymorpha,* then they seem to loose their specific values to some extent, and seem to fit more or less into certain groups, notwithstanding existing gaps.

When discussing the distribution of the varieties, the matter becomes a good deal more difficult. It is not an easy matter to visit every locality on all the islands of the group, so what is stated here in the following lines is not to be taken as the actual limits of distribution, but simply records of location where certain varieties occur on the Island of Hawaii, we will begin with that Island, and simply mention the locations of the other varieties found on the other islands later on. The same variety may occur on the most varied topography, the actual characteristics which constitute the particular variety remain the same, or are parhaps slightly modified, but the habit of the plant is quite altered. For example: var. *incana* occurs along the Waiakea River, and on the grassy slopes down to the sea; on the bluffs of the stream it is stunted, in fact at that elevation it is never taller than 6-10 feet, while the same variety in the forests of Puna and in the Kipuka Puaulu near the Volcano of Kilauea, is a tree of nearly 100 feet in height (See plate IV), while again on pahoehoe lava flows it is a small tree 30-40 feet in height starting as a shrub with branches down to the ground, (see plate V). In fact, var. *incana* is the commonest variety of *Metrosideros collina polymorpha;* it is practically the only one which occurs in pure stands together with tree ferns. It favors the newer lava flows where it begins life as an epiphyte on smaller ferns, it takes possession of the tree fern forests, starting life again as an epiphyte, the tree fern being the supporting plant, which later succumbs as the tree gains dimensions; this accounts for the many stilt roots of Ohia lehuas. (See plate III.)

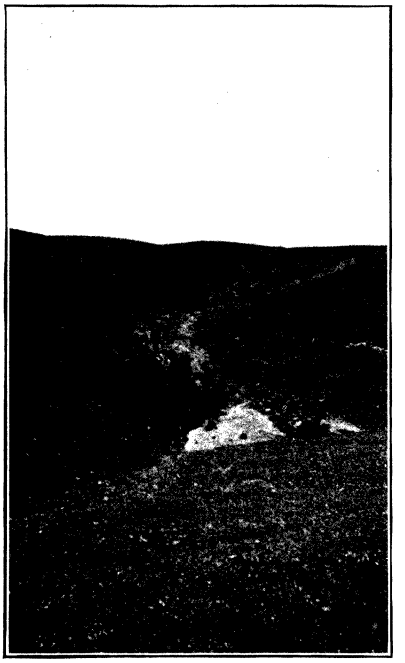
The amount of seed produced by a single Ohia tree is enormous and as it is feather light, is blown by the wind over the vast open areas, mainly lava flows intersecting forest belts, where they lodge themselves in the woolly scales of ferns, which, owing to their fine spores, are the first to establish themselves. Later on when a stand of Ohia has succeeded the smaller ferns, and the resulting

PLATE X.

a

Vault pahoehoe or smooth lava with little soil, occupied by **Metrosideros collina polymorpha** var. **incana,** on the slopes of Mauna Loa, elevation 5000-6000 feet.

b



Metrosideros collina polymorpha var. **incana** growing along dry watercourse in the ash fields of the Kau desert on Hawaii.

shade and development of humus due to the disintegration of the lava caused by its being broken up by the strong roots of the Ohias, admitting moisture, and leaf mould, the tree ferns then appear on the scene; after they have established themselves, the succeeding generations of Ohias begin their life on the larger tree ferns, thus building up larger, that is taller, forest trees. (See plates VI, VII, and VIII.)

This may be simply a step towards the upbuilding of another type of forest as can be seen in the older regions near the Volcano of Kilauea. The disintegration of the tree fern trunks, the accumulation of humus and the birds acting as the agent of distribution, the ground having been prepared, the frugiferous birds finding shelter in the forests bring with them in their crops or stomachs fleshy seeds of trees such as *Antidesma, Ilex, Cheirodendron, Broussaisia* and others; these find a ground ready to receive them and a second type of forest of a more mesophytic nature develops. If left to itself, undisturbed for centuries, forest types develop, such as we find in the mountains of Kohala. This may be only attributable to Hawaii, for *Metrosideros* is a late arrival in this group, as compared with the much older trees found on the other islands which have, however, spread over Hawaii to a certain extent in certain regions, which were ready to receive them. The variety *Newellii* is also very common on Hawaii, but mainly in the vicinity of Hilo along the Waiakea River, and on the lava flow beyond. It is seldom a big tree, more often a shrub. Var. *macrophylla* is confined to the very wet forests in the neighborhood of Mountainview, and near Glenwood; it favors the rainbelt at an elevation of 2000 feet. The var. *α typica* occurs also on Hawaii, and is especially common at the Volcano of Kilauea, growing in company with var. *incana*, which it resembles greatly, and is often only with difficulty distinguished. It inhabits also the forests of Oahu, back of Honolulu, where it becomes a good sized tree.

The var. *imbricata* is only found on Oahu in the mountains and valleys of the windward side at lower elevations.

The very distinct variety *Haleakalensis*, as the name implies, is found on the upper slopes of Mt. Haleakala, Maui, in the gulches of the crater of Puunianiau, in company with *Raillardia, Santalum, Styphelia*, etc.

The varieties *pumila* and *glabrifolia* both inhabit the Island of Kauai, the former is stunted and peculiar to the bog at Wahiawa, while the other is a tree in the forests of Kaholuamano on the high plateau of the Waimea district.

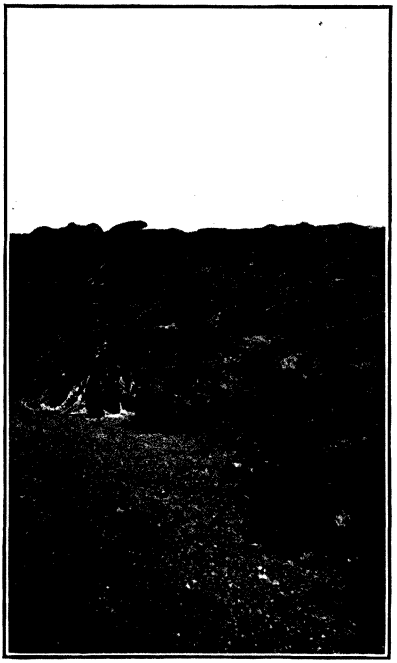
Var. *prostrata* occurs in the high mountain bogs at the summits of Waialeale of Kauai and Puukukui of West Maui; on Molokai it grows in the Kawela swamp at an elevation of 4000 feet; its form *strigosa* is only found in the summit bog of Kohala, Hawaii, in company with *Viola, Plantago, Vaccinium, Orcobulus*, etc.

Molokai harbors another rather interesting variety, var. *Faurici*, it is a handsome, medium sized tree and favors the lee side of the island, especially the open slopes and sides of gulches, as in Mapolehu and Kamolo.

There remains only one more variety, var. *glaberrima*, very plentiful on Oahu in the mountains of the main range; its form *sericea* is found on Oahu as well as on Hawaii, Kauai, Molokai and Lanai, and probably also on Maui. For further, more detailed references to location, see under each species and variety in the systematic part.

PLATE XI.

a



A rather recent (pahoehoe) smooth lava flow, with **Metrosideros collina polymorpha** var. **incana**, and **Sadleria cyatheoides** growing on its margin. An overflow from the Volcano of Kilauea, Hawaii, on to the ash fields of Kau desert.

b

The two floors of a crater occupied solely by **Metrosideros collina polymorpha** var. **incana**. The crater is one of the numerous ones found in the vicinity of Kilauea on Hawaii. The trees on the lower floor are 50-60 feet in height.

c

An old aa or rough lava flow occupied by **Metrosideros collina polymorpha** var. **incana**, and encircling an ancient kipuka or oasis with a most varied arborescent vegetation, and where no trace of lava can be found.

METROSIDEROS COLLINA POLYMORPHA VARIETY INCANA ON HAWAII

The variety *incana,* as already remarked in the systematic part of this paper, is the most common variety on the Island of Hawaii, in fact the bulk of the forests which cover the geologically younger land areas, is composed of this variety. Of all *Metrosideros* the variety *incana* seems to be the most able to adapt itself to almost any altitude and environment. On Hawaii variety *incana* is ever present, as near the sea shore, in the forests of Puna and the forest belt on the slopes of Mauna Kea (windward side), the forests of Mauna Loa on both the leeward and windward slopes. It is most common around the Volcano of Kilauea where it grows on the open cinder fields near Halemaumau, along the hot steam cracks and fissures near and at the sulphur banks where they are covered with the whitish yellow sulphur deposits giving it the appearance of being covered with snow. Even under such conditions, as within the reach of steam, issuing from the volcanic depths below, variety *incana* flowers and fruits profusely.

To be sure it does not reach the size of a tree, but is more shrubby and rarely higher than fifteen feet. In the forests of the immediate neighborhood of Kilauea, variety *incana* forms pure stands, the trees being usually 40 to 50 feet in height with tree ferns forming the main undergrowth save a species of Pipturus which grows usually on the outskirts. (See plate IX). This ohia lehua forest becomes less dense as it approaches the cinder field near the actual crater and the smaller one of Keanakakoi. The trees decrease in size and are scattered rather than growing in stands, while on the floor of the crater Keanakakoi it lives only in cracks of the basaltic pahoehoe lava. (See plate IX b.) The adjacent land passes gradually into the Kau desert practically devoid of all vegetation, not due to lack of rainfall, but mainly to the composition of the volcanic ash, which on coming in contact with moisture becomes cemented and forms thus a surface similar to hard pan on which plants cannot establish themselves. Besides the prevailing wind brings with it the dense sulphurous fumes of Halemaumau crater, which sweep this desert continuously. (See plates X b, and XI a.)

However variety *incana* is not absent in the most desolate of all regions. The Kona (south) wind causes during the winter months heavy downpours and consequently rivulets form in the beds of which variety *incana* has found it possible to exist. The young plants found in these locations are often completely enwrapped by the so called "Pele's Hair," which is simply lava spun into hair like threads and blown about and carried by the wind over large areas. Variety *incana* thrives in the cracks of the smoothest (pahoehoe) lava, as well as on the roughest and most recently ejected aa lava. (See plate IX c.) It covers the old aa (rough) lava flows of both south and north Kona, as well as the pahoehoe (smooth) lava flows on the upper slopes of Mauna Loa along the trail leading to Mauna Kea elevation 5000-6000 feet. There it grows in pure stands without undergrowth save the bracken fern (*Pteridium aquilinum*) and a few other herbaceous plants. These forests cover only the newer land. They are bordered by koa forests (*Acacia koa*), pure stands of magnificent trees which cover only the geologically older regions; the demarcation between these two forest types is so distinct that one could divide them by ropes. (See plate X a.)

Variety *incana*, it will be remembered, is the closest *Metrosideros* to the South Sea Island *Metrosideros collina*. The latter has the widest distribution of any *Metrosideros* known and it may not be wondered at that its closest congener, with which it may have been once identical, should have such wonderful adaptability to the most varied environments.

The smaller illustrations show variety *incana* on the various above cited locations. (Plates IX, X, XI.)

Insects injurious to **Metrosideros collina**, subsp. **polymorpha** in the Hawaiian Islands*

Homoptera.

Delphacidae. The endemic genera of Hawaiian Delphacidae belong to the tribe Alohini, of which two species are known outside of the Hawaiian archipelago, viz., one in Australia and on in South America. The Hawaiian genera form two groups, the *Leialohae* consisting of two genera, *Leialoha* and *Nesodryas;* and the *Alohae* with four genera, only *Leialohae* are known to live upon *Metrosideros*. There are a good many reasons to believe that the *Alohae* were much earlier immigrants into the Hawaiian archipelago than the *Leialohae*. Of the two genera, *Leialoha* and *Nesodryas*, the former is the more primitive. At present it consists of five species and three subspecies. The food plant of two species (*oceanides* from Kauai, and *pacifica* of uncertain locality) is unknown, the others all feed upon *Metrosideros*. Two species of *Nesodryas*, *N. gulickii* and *N. maculata*, both from the lava flows of South Kona feed upon *Metrosideros*.

Tetigoniidae.

No species are recorded as feeding on *Metrosideros*, although several species do feed upon it.

Psyllidae.

Several species belonging to this family are attached to *Metrosideros*, only one of which is described at present, *Trioza iolani* Kirk., which forms galls on the leaves.

Coleoptera.

There are several beetles of the genus *Plagithmysus* which live in the wood of the *Ohia* tree. Their names and localities are as follows:

P. bilineatus on Hawaii.

P. lanaiensis on Lanai.

P. pulvillatus on Maui.

P. aestivus on Molokai.

Lepidoptera.

The following moths and their larvae live on *Metrosideros:*

Philodora splendida Walsm. Leaf-miner.

Eccoptera foctorivorans Butt. On leaves and in buds.

Heterocrossa distincta Walms. In leaf buds.

The larvae of the following three species of moths live in cases on lichens found on the bark of *Metrosideros*:

Hyposmocoma metrosiderella Walms.

Hyposmocoma bacillella Walms.

Hyposmocoma subcitrella Walms.

* For the information contained in this chapter the writer is indebted to Mr. Fred. Muir and Mr. Otto H. Swezey, Entomologists at the Hawaiian Sugar Planters' Experiment Station.

Metrosideros Banks

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SYSTEMATIC PART.

KEY TO SPECIES

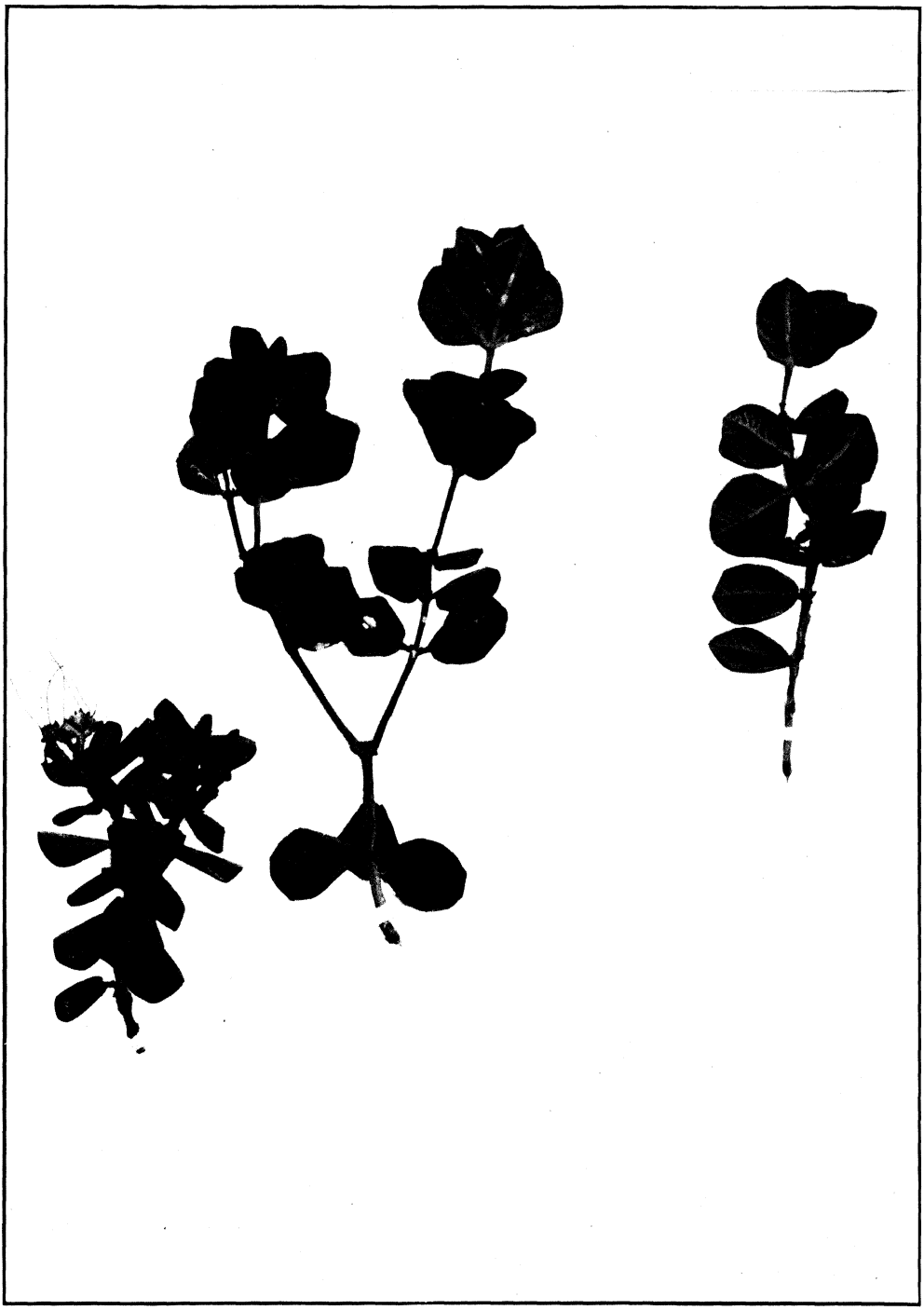
Leaves on short petioles up to 2 cm.
- Leaves faintly nerved, capsules almost free;
  - Branches drooping, slender, numerous, leaves narrow lanceolate, petioles flat, slightly winged, 6 mm..... **M. tremuloides**
  - Branches ascending stiff:
    - Leaf-buds divaricately spreading, long, narrow cylindrical, acuminate; leaves caudately acuminate ..... **M. Waialealae**
    - Leaf-buds large, broad, obtuse and erect ..... **M. collina polymorpha**
- Leaves deeply rugose, impressed above, the strong nerves ridged below; capsule adnate to near the apex ..... **M. rugosa**

Leaves on long petioles of 2.5-5 cm. ..... **M. macropus**

KEY TO THE VARIETIES AND FORMS OF **METROSIDEROS COLLINA POLYMORPHA**

Leaves woolly or canescent, inflorescence woolly:
- Leaves thick coriaceous, densely woolly underneath:
  - Leaves orbicular, cordate, subsessile ..... var. α **typica**
  - Leaves obovate to elliptical oblong, rounded at the base, petiole 6-12 mm: ..... var. **incana**
- Leaves thin, canescent, imbricate ..... var. **imbricata**

Leaves glabrous:
- Inforescence woolly:
  - Trees:
    - Leaves thick coriaceous, suborbicular cordate, subsessile, petioles about 1 mm., capsule large ..... var. **Haleakalensis**
    - Leaves subcoriaceous, elliptical, acute at both ends, petioles 6-10 mm., capsule small ..... var. **Newellii**
  - Shrubs or creepers:
    - Shrub, leaves broadly ovate, petioles stout, 6 mm. (growing in Wahiawa swamp, Kauai, only) ..... var. **pumila**
    - Creeper, leaves small suborbicular to ovate, (growing summit swamps) ..... var. **prostrata**
- Inflorescence silky, canescent or glabrous:
  - Inflorescence silky canescent:
    - Petioles long 1-2 cm.:
      - Leaves linear-oblong, bluntly acute at both ends, capsule glabrous ..... var. **Fauriei**
      - Leaves large, ovate, obtuse at apex, truncate at base, capsule canescent ..... var. **macrophylla**
    - Petioles short, less than 3 mm., leaves broadly cordate at base.... var. **glabrifolia**
  - Inflorescence glabrous, glabrous in all parts, leaves variable, petioles 3-10 mm. ..... var. **glaberrima**



Metrosideros rugosa A. Gray. Type in Gray Herbarium.

Metrosideros rugosa, A. Gray, Bot. U. S. Expl. Exp. 14: 561, T. 69 B. (not A.) 1854.

Metrosideros polymorpha, Drake del Cast. Ill. Flo. Ins. Mar. Pacif. VI: 167. 1890.

Nani rugosa O. Ktze. Rev. Gen. Pl. I: 242. 1891.

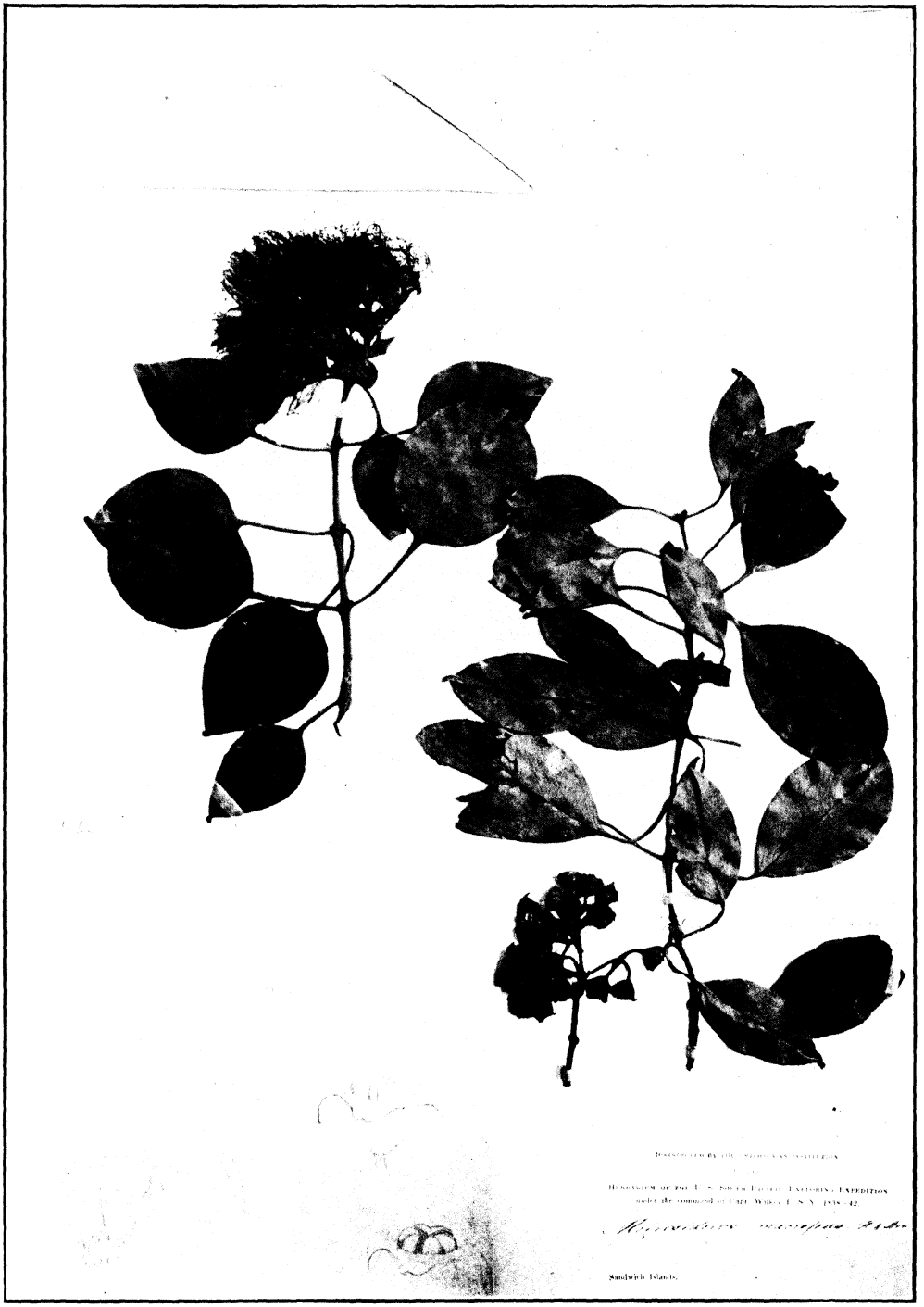
A small tree or shrub, with guadrangular branchlets, only the ultimate ones tomentose; leaves orbicular, about 2.5 cm. in diam., thick coriaceous, strikingly bullate rugose above, with the strong pinnate veins impressed, very prominent underneath as well as the thick costa, upper surface minutely pubescent when young, but soon glabrate; the lower tomentose with a thick and close, nearly persistent, tawny and ferruginous wool, as are the leaf buds on both faces; petioles very short, scarcely 2 mm.; cymes small, solitary or in pairs at the summit of the branches, peduncles and their divisions short and stout, whitish tomentose, the whole subtended by rather conspicuous and coriaceous bud scales, which are somewhat persistent after the evolution of the cyme; bractlets as long as the calyx, oval, tomentose, somewhat ferruginous, soon deciduous; pedicels very short or scarely any; flowers large; calyx densely tomentose with whitish wool outside, turbinate, five-lobed; petals and stamens deep red, the former slightly pubescent; ovary deeply immersed in the bottom of the calyx, three-celled, its summit only free.

OAHU: On the mountains behind Honolulu, A. Gray;—Gaudichaud, Voy. Bonite;—dry hills back of Honolulu and Niu Valley, Hillebrand;—Koolau Mts., open ridges overlooking Hauula, elev. 2500 feet, flowering Aug. 17, 1908, Rock, No. 138, in College of Hawaii Herb. (two sheets);—Punaluu Mts., flowering Nov. 14-21, 1908, Rock, No. 646, in College of Hawaii Herb.;—same locality, flowering Dec. 24-29, 1908, Rock, No. 922, in College of Hawaii Herb.;—summit of Koolau range between Mt. Olympus and Konahuanui, overlooking the precipice above Waimanalo, April, 1913, Rock.

The *Lehua papa,* as this species is called by the natives, is certainly distinct, and is confined to the Island of Oahu, where it grows in open situations, but rarely on the dry hills, as Hillebrand states; on the contrary, it is confined to the very summits of the windswept ridges, which are more or less hidden in trade wind clouds. It is never really a tree, but usually a bush or shrub, growing on the vertical cliffs or palis on the windward side of the island, only in the Punaluu Mts. did the writer observe it as a small tree, 10 feet or so in height. It is a handsome species and conspicuous on account of its dark green, rugose foliage, which is ochre colored, and woolly underneath, and its bright scarlet flowers, which are terminal.

The plate in the Atlas of the U. S. Exploring Expedition is erroneously marked; the plant designated by the letter "B" is *Metrosideros rugosa,* and not "A."

In the Gray Herbarium is one sheet of this species, a co-type of Asa Gray's, with what is probably the original drawing for the Atlas of the Botany of the U. S. Exploring Expedition. The specimen was distributed by the Smithsonian Institute. On the same sheet is a small specimen of this species collected by Gaudichaud during the visit of the Bonite.



Metrosideros macropus Hook. et Arn.

Metrosideros macropus Hook. et Arn. Bot. Beech. Voy. 83. 1841.
Nani macropus O. Ktze. Rev. Gen. Pl. 1: 242. 1891.

A well-proportioned tree of considerable size, glabrous throughout; the branchlets angled; leaves ovate or ovate-oblong, coriaceous, rather dull, acute at the base, either rounded, obtuse, or somewhat acute at the apex, obscurely punctate, copiously feather-veined, the veins oblique, very slender, equally conspicuous on both sides, connected by minute reticulations, terminating in an infra-marginal nerve; petioles elongated, sometimes almost as long as the blade, 2.5-5 cm. long, usually margined, and standing nearly at right angles to the stem; cymes terminal, usually geminate, subsessile, many-flowered, crowded, evolved from a large scaly bud, the scales of which remain persistent for some time, as ovate or oblong pointed bracts, of a coriaceochartaceous texture, 12 mm. in length; the pedicels about 4 mm., subtended by smaller ovate-lanceolate, early deciduous bractlets; flowers large, calyx glabrous or barely puberulent, petals and stamens pale or flesh-color; ovary three-celled, the glabrous summit free barely to the middle; capsule nearly included in the turbinate tube of the calyx, the spreading lobes of which are persistent, free to the middle, adnate below, three-valved, many seeded; seeds fusiform-subulate, not much pointed.

OAHU: On the mountains behind Honolulu, Macrae, Lay et Collie, Gaudichaud, Seeman, U. S. Expl. Exped., Remy No. 642, Mann et Brigham;—Mt. Waiolani, Wawra No. 1656 in Herb. Vienna;—Nuuanu to Palolo, Hillebrand;—Mts. of Waikane, windward side of Oahu, flowering and fruiting Jan. 23, 1909, Rock, Nos. 1229 (flowering), 1230 (fruiting) in College of Hawaii Herb.;—Kalihi Valley, Oct., 1909, Abbe Faurie No. 22, Herb. St. Louis College, Honolulu.

This species is quite distinct from the other species of *Metrosideros* and differs from them mainly in the long petioled leaves, large floral scales, very large flowers, and large capsules which are nearly included in the calyx tubes.

It is a tree of considerable size and is not uncommon in the mountains of Oahu, especially on the main Koolau range, in the middle forest zone. The writer found this species most plentiful on the ridges of Waiahole and Waikane. The flowers are not red, but pale or flesh-colored.

Léveillé describes two hybrids, one x *Nania* (*Metrosideros*) *Faurici* (*N. macropus* Hook. et Arn. x *N. polymorpha* Gaud.) which does not belong here; the other: x*Nania* (*Metrosideros*) *Feddei* (*N. polymorpha* Gaud. x *N. macropus* Hook.), which is quite a distinct species and known as *Metrosideros tremuloides* (Heller) P. Knuth.

The variety *microphylla* Lévl. of *Metrosideros macropus*, collected by Faurie at Koloa, Kauai, is not known by the writer. Co-types of the two above mentioned (supposed) hybrids are in the College of Hawaii Herbarium.

In the Gray Herbarium is a specimen (fruits only) from the Herb. of the U. S. South Pacific Expl. Expedition, with the original drawings which served for the illustration in the Atlas of the Botany of the above-mentioned expedition. On the same sheet is a paper pocket containing a few fruits, and the following legend:

"From Byron's Bay, Hawaii, Macrae! Is a spec . . . (part of the line is not legible) by Planchon." "Specimen inter *M. polymorpha* Gaud. et *M. macropus* H. et A. medium invalidating the two species." It bears the number 1731. The fruits are identical with those of the U. S. Expl. Expedition. On the same sheet is a flowering specimen collected by Seeman on Oahu with the same number 1731, and another specimen collected by Gaudichaud, on Oahu, visit of

Metrosideros Waialealae Rock. Type in College of Hawaii Herbarium.

the Bonite. The Seeman specimen has almost orbicular leaves, while that of Gaudichaud has obovate leaves.

Another sheet (flowering specimen) collected by Macrae, May, 1825, on Oahu, belongs here, the leaves are ovate acute. A very handsome specimen with flower buds and mature fruits collected by W. T. Brigham on Oahu in 1865, also in the Gray Herbarium, shows the floral scales to great advantage, as they are usually deciduous at the maturity of the flowers.

Heller's No. 2762, labeled *Nania macropus* (H. et A.) Kuntze, has nothing in common with *M. macropus* H. et A. It belongs to *M. collina* subsp. *polymorpha* var. *glaberrima* (Lévl.) Rock; this specimen came from Hanapepe, Kauai.

The writer is of the opinion that the few fruits marked as having come from Byron's Bay, Hawaii, by Macrae, might have been mixed up, and that they really belong to his Oahu specimen. So far the true *M. macropus* has not been found outside of Oahu.

Metrosideros Waialealae Rock.

Metrosideros tremuloides var. *Waialealae* Rock, Indig. Trees Haw. Isl. 335. 1913.

A medium-sized tree, 10 m. or more in height; sparingly branched, branches ascending glabrous, terete; leaves bright pale-yellowish green, with carmine midrib and leaf-margin, veins protruding and prominent above, paler than the leaf, the inframarginal nerve close to the edge, thick coriaceous, 5-7 cm. long, 2-2.5 cm. wide, elliptical-oblong to ovate, caudately-acuminate at the apex, acute at the base and merging into a flat, bright red petiole of 15-20 mm.; cymes terminal, large and many-flowered, 4 cm. in height; peduncles 1.5 cm. or more, glabrous; pedicels 2 mm.; flowers large, bright red; calyx green, glabrous, with reddish margins; petals large, obovate, rounded; stamens 2 cm.; the stigma 2.5 cm.; fruits as large as in **M. macropus**, the calyx-lobes persistent, prominently 5-ribbed, the capsule free from the calyx tube, and projecting beyond the latter; seeds linear, lunulate, pointed at each end.

KAUAI: Near summit ridge leading to Mt. Waialeale, elevation 5200 feet, flowering and fruiting Sept. 24, 1909, Rock, type No. 5083, in the College of Hawaii Herbarium;—same locality, flowering Oct. 20, 1916, Rock and Hitchcock, No. 12781 in College of Hawaii Herbarium and A. S. Hitchcock, No. 15486 in U. S. Nat. Herbarium.

A very interesting and rather distinct species which resembles somewhat *M. tremuloides*. It comes close to *M. macropus* in the long petioles, but differs from it in the absence of floral scales and bracts, the free capsule projecting beyond the calycine tube.

It is a striking species and perhaps the handsomest *Metrosideros* occurring in these Islands. It has so far only been found on a single ridge leading from Kaluiti and Kailiili stream to the summit of Waialeale, where it forms a pure stand of an acre or so in extent.

Metrosideros tremuloides (Heller) P. Knuth.

Metrosideros tremuloides *(Heller) P. Knuth Handbuch der Blueten-biologie 3: 532. 1904.

Metrosideros tremuloides (Heller) Rock Indig. Trees Haw. Isl. 333, Pl. 133. 1913.

Metrosideros polymorpha Gaud. var. ζ Gray (in part) Bot. U. S. E. E., 653. 1854.

Metrosideros polymorpha Gaud. var. 6 H. Mann, Proc. Ess. Inst. 5: 244. 1867.

Metrosideros polymorpha Gaud. var. η Hbd. Flora Haw. Isl. 127. 1888.

Nani (*a*) *tremuloides* Heller in Minnes. Bot. Stud. 9: 866. 1897.

x *Nania* (*Metrosideros*) Feddei H. Lévl. in Fedde Rep. Spec. Nov. 10: 150. 1912.

Metrosideros polymorpha Gaud. var. β Rock in part (No. 4829). Indig. Trees Haw. Isl. 327. 1913.

A small tree, with slender trunk, bark grayish, smooth, glabrous throughout; branches many, slender, loosely spreading; leaves narrow-lanceolate, acute or acuminate at both ends, 3.5-5 cm. long, 10-16 mm. broad, on slightly winged or flat petioles of 6 mm., bright green, shining above, paler and dull underneath, coriaceous, not prominently veined, but midrib conspicuous, leaf margins, midrib and petioles of a reddish color; cyme branches divaricate; peduncles slender, of varying length, hardly longer than 10 mm.; ultimate pedicels about 3 mm.; calyx campanulate, the lobes rounded and equaling the tube in length, encircled by a lighter green, minutely ciliate or scarious margin of one-third of a millimeter in width; petals bright red, almost orbicular, twice the length of the calyx lobes, the margins scarious; stamens bright red, barely 2 cm. in length; style 2 cm.; capsules half free.

OAHU: Gaudichaud, voyage Bonite;—U. S. E. E. (1838-42);—Mann and Brigham No. 96a;—in sheltered gulches on the lee side of Oahu, Hillebrand, July, 1865;—at the Nuuanu Pali, Oct. 29, 1895 Heller No. 2895;—at the head of Pauoa Valley, flowering Jan. 8, 1910, Rock No. 137, and eastern ridge of Niu Valley, flowering Aug. 22, 1909, No. 4827;—Kalihi Valley, flowering Oct. 1909, Abbe Faurie No. 25, No. 12611 in the College of Hawaii Herbarium.

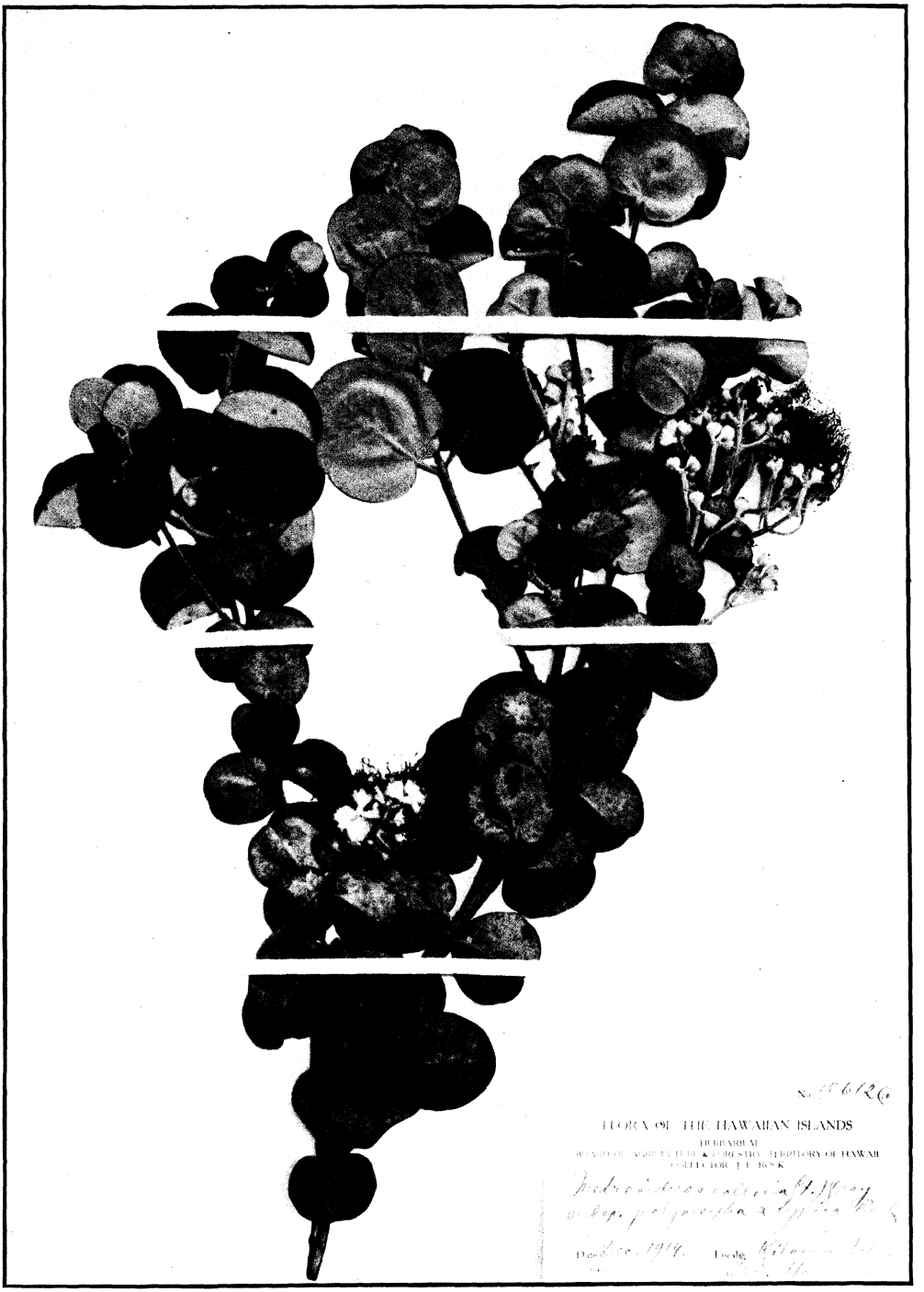
One of the handsomest and most graceful of the species of the genus *Metrosideros*. The natives know this species by the name *Lehua ahihi*. The bright green foliage with the reddish margin, midrib and petiole, stands out quite distinct from all the other species. It is entirely glabrous, even calyx and corolla, which are usually covered with a silvery tomentum in the other species or varieties. The branches are numerous, drooping, terete and very slender, and nearly always in motion, hence the specific name.

The species was collected by nearly all the earlier botanists and exploring expeditions, and was first described by Gray, though it may be Gaudichaud's var. γ mentioned in the Voyage Uranie. H. Léveillé's x *Nania Feddei* is the typical *Metrosideros tremuloides*, not a hybrid.

The tree is peculiar to the main range of Oahu, especially common in the valleys of Kalihi, Manoa, Nuuanu and Pauoa, though occuring as far east as Niu Valley. Hillebrand mentions it from Kauai, but the writer has not seen specimens nor has he collected it on that island.

In the Gray Herbarium are several sheets with specimens of the typical *Metrosideros tremuloides*, though mounted often with other varieties of *M.*

* The writer was not aware that Prof. P. Knuth had placed Heller's **Nani (a) tremuloides** into **Metrosideros** at the time of publication of the Indigenous Trees of the Hawaiian Islands. Prof. Knuth's book is not available in Honolulu.



Metrosideros collina (Forster) Gray subspec. **polymorpha** (Gaud.) var. *a* **typica** Rock.

polymorpha. A co-type of the species (Heller No. 2895) is in the Gray and College of Hawaii Herbaria.

Specimens examined:—Heller No. 2895, Hillebrand (July, 1865) without number;—U. S. Exploring Expedition labeled *M. polymorpha* ζ;—Mann and Brigham No. 96a, labeled *M. polymorpha* ζ;—several fragments of this species mounted with other specimens from the voyage Bonite, Gaudichaud. All these specimens are in the Gray Herbarium, Harvard.

Seeman's No. 171 of *Metrosideros polymorpha* var. β with yellow flowers, from Fiji, collected by him in 1860 (specimen in Gray Herbarium) comes very close to *M. tremuloides* in general appearance, but differs from it in the sessile yellow flowers and much contracted cymes. A. Gray unites Seeman's var. β 171 with his *M. collina* var. *viticnsis*, also from Fiji, but it has not much in common with it. Gray's var. *viticnsis* has a silky canescent inflorescence, and broader ovate elliptical leaves, while Seeman's No. 171 has a much contracted perfectly glabrous cyme and leaves as in *M. tremuloides*. Seeman's var. α with red flowers, No. 170, seems also closely related to it.

Metrosideros collina (Forster) A. Gray subsp. **polymorpha** (Gaud.) α **typica** Rock

Metrosideros polymorpha Gaud. Bot Voy. Uranie, 482, Pl. 108. 1826.

Metrosideros polymorpha Gaud. var. β Gray, Bot. U. S. E. E., 562. 1854.

Nania polymorpha Gaud. var. *nummularifolia*. Lévl., in Fedde Report, Spec. Nov. 10: 149. 1911.

Metrosideros polymorpha Gaud. var ι Rock Indig. Trees Haw. Isl. 331, Pl. 138. 1913.

A medium-sized stree 5-10 m. high, with robust terete branches; leaves thick coriaceous, orbicular to suborbicular, 1.5-6 cm. in diameter; dull glabrous above, or somewhat shining (in Oahu specimens) cordate at the base and often retuse at the apex, densely gray or white-woolly underneath, intramarginal nerve 1-2 mm. from the leaf-margin, the nerves raised and prominent; petioles short, pubescent, 2-4 mm.; inflorescence a cyme or open raceme, densely white-woolly as are the calyx, calyx-lobes and in part the petals; ultimate pedicels very short, 1-3 mm.; bracteoles ovate, rounded, woolly, 3-5 mm.; calyx large and broad 5 mm. including the rounded lobes; petals rounded; stamens about 2 cm.; style about 23 mm. long, protruding; capsule densely woolly, about 6-7 mm., exserted from the calycine tube.

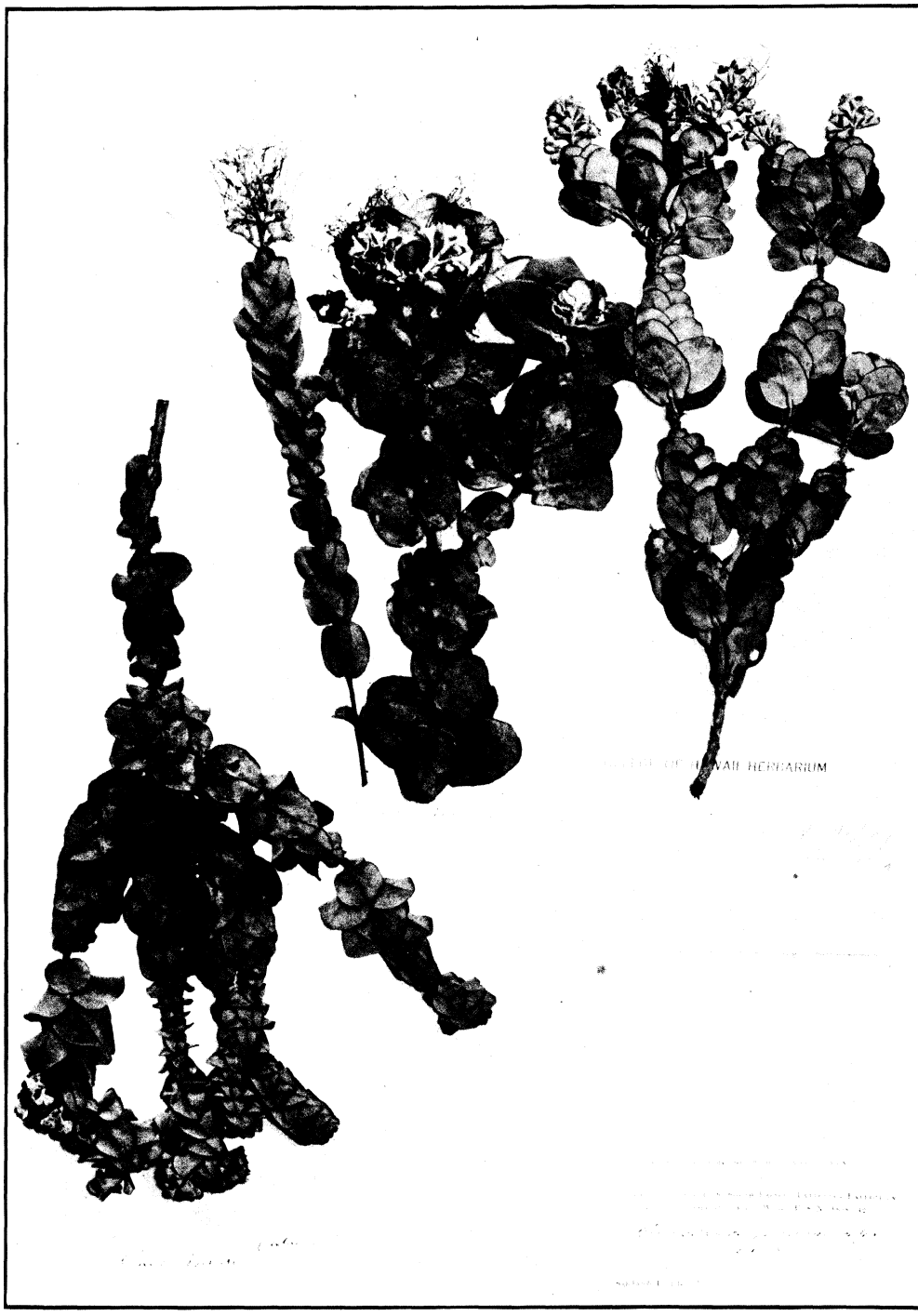
OAHU: Mann and Brigham, No. 72;—Nuuanu Valley, 2000-3000 feet, Hillebrand;—slopes of Konahuanui, above Manoa, flower-Nov. 12-13, 1895, Heller No. 2375;—Koolau Mts., Kaliuwaa Ridge, above Hauula, without flowers or fruit, Dec. 24, 1908, Rock, No. 847 in College of Hawaii Herbarium.

KAUAI: Hbd.?—Specimens not seen;—U. S. E. E.

MAUI: Hbd.?—specimens not seen;—U. S. E. E. Crater of Haleakala, specimens not seen.

HAWAII: Gaud.? (Sandwich Islands);—near the coast and on Mauna Loa, U. S. E. E., 1838-1842;—mountains of Hawaii, Hbd.;—Volcano of Kilauea, May, 1909, Faurie, No. 34;—summit of Mt. Hualalai, Honuaulu Crater, fruiting June 9, 1909, Rock, No. 3712;—lava beds on slopes of Mt. Hualalai, North Kona, flowers yellow, flowering June, 1909, Nos. 3633, 3635, 3617, and 3626;—Volcano of Kilauea, flowering Dec., 1914, Rock, Nos. 12612 and 12613a from Kilauea-iki.

PLATE XVII.



Metrosideros collina (Forster) A. Gray subsp. **polymorpha** (Gaud.) var. **imbricata** Rock. Type in Gray Herbarium.

The variety *α typica*, which is identical with Gaudichaud's type of *Metrosideros polymorpha*, plate 108 in Botany Voyage Uranie, is a rather small tree with gnarled trunk and branches, and occurs on the islands of Oahu, Maui and Hawaii. It is distinguished from the other varieties in the cordate, subsessile or shortly pedunculate, suborbicular leaves, which are densely woolly underneath, as is the whole inflorescence. The specimens from Oahu and Mt. Hualalai, Hawaii, have a rather contracted cyme, while those from the neighborhood of the Volcano of Kilauea, Hawaii, have large open cymes to a racemose inflorescence. The leaves of the Oahu specimens differ from the Hawaii specimens in being somewhat shiny above and have an impressed midrib. The specimen No. 3712, from the summit of Mt. Hualalai, Honuaulu Crater, has very small leaves and tomentose branches, the woolliness on the leaves is grayish and that of the younger leaves or buds yellowish. The bark is thin, reddish and peels off in small flakes. The variety *α typica* was collected practically by all the earlier botanists. Besides occurring on Oahu and Maui, it is common in the neighborhood of the Kilauea Volcano, Hawaii, where it grows along the sulphur bank and hot steam cracks as a shrub or small tree, usually covered with sulphur.

Metrosideros collina (Forster) A. Gray subsp. **polymorpha,** var **imbricata,** Rock.

Metrosideros polymorpha Gaud. var. *α* A. Gray, Bot. U. S. E. E. 562. 1854.

Metrosideros polymorpha Gaud. var. 1 H. Mann, in Proc. Essex Inst. 5: 243. 1868.

Metrosideros polymorpha Gaud. var. *ι* Rock, Indig. Trees, Haw. Isl. 331. 1913.

A small tree or shrub, leaves rounded, thin in texture, cordate, subsessile or very shortly petiolate, crowded on the branches and often imbricate, becoming gradually smaller towards the apex of the branchlets, canescent below, glabrous and shining above, 6. mm.-3 cm. in diameter, the veins scarcely visible; cymes contracted or elongate, canescent to white-tomentose, flowers small; calyx white tomentose, with the exception of the tips of the calycine lobes, the margin of the latter as well as that of the red petals, whitish pubescent; stamens about 2 cm., style slightly longer; capsules small, 4 mm. tomentose, the valves projecting from the calyx and glabrous.

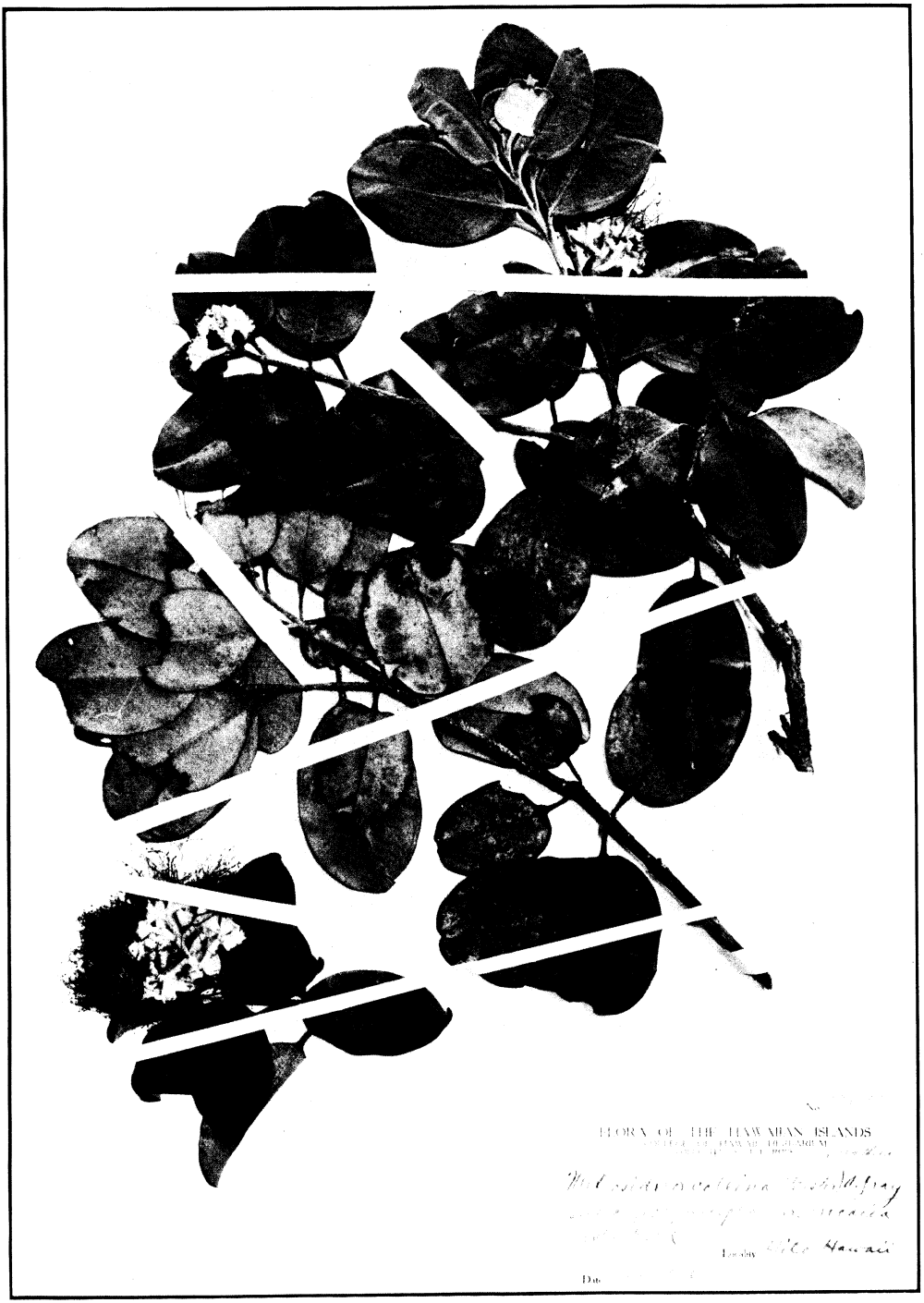
OAHU: Gaud. Voyage Bonite in Gray Herbarium;—Seemann No. 2288 in Gray Herbarium;—mountains behind Honolulu, U. S. E. E., in Gray Herbarium;—Kaliuwaa Valley, flowering Aug. 15, 1908, Rock, No. 720;—Pauoa Valley, fruiting Oct. 26, 1908, Rock, No. 722;—mountains of Punaluu, May, 1909, Faurie, No. 33 (?). HAWAII: Hillebrand (doubtful), specimens not seen.

This rather distinct variety differs from the var. *α typica* mainly in the subsessile, imbricately arranged suborbicular, rather thin, leaves, and in the smaller flowers and capsules. It occurs in the mountains behind Honolulu on high exposed ridges. Hillebrand records it also as growing in the Kohala Mountains on Hawaii. It is Hillebrand's and Asa Gray's var. *α* and the writer's var. *ι* No. 722, in the Indigenous Trees of the Hawaiian Islands, and probably Faurie's var. *sessilis*, No. 33, from the Punaluu mountains.

The specimens from Kaliuwaa Valley (No. 720) have the leaves less imbricate and slightly larger, but otherwise exactly the same.

In the Gray Herbarium are three specimens each by a different collector (Gaudichaud, Seemann, and U. S. E. E.) on one sheet, which is here reproduced and is the type of var. *imbricata* Rock.

PLATE XVIII.



Metrosideros collina (Forster) A. Gray subsp. **polymorpha** var. **incana** (Levl.)

Metrosideros collina (Forster) A. Gray, subsp. **polymorpha** var. **incana** (Lévl.) Rock.

Metrosideros polymorpha Gaud. var. β Gray in part, U. S. E. E., 562. 1854.
Metrosideros polymorpha Gaud. var. ε Hbd. Fl. Haw. Isl. 126. 1888.
Nania polymorpha (Gaud.) var. *incana* Lévl. in part, in Fedde Repert. Spec. Nov. X: 149. 1911.

A shrub or tree reaching a height of 30 m. or more; trunks straight ascending; sometimes two or three from the same root stock; bark gray, outer layer falling off in flakes or strips; branches stiff, more or less ascending, terete or angular when young; leaves coriaceous, obovate, ovate or elliptical-oblong, acute or usually obtuse, cinereo-tomentose on both faces, but older leaves becoming glabrous above, 2.5-7.0 cm. long, 2-4 cm. wide, on petioles of 6-12 mm.; cymes densely tomentose, many-flowered, pedicels very short, 1-5 mm.; calyx white-woolly, 5 mm., including the lobes; petals oblong, tomentose or glabrate, with ciliate margins; capsule grayish woolly, slightly exserted, or immersed in the Kauai specimens.

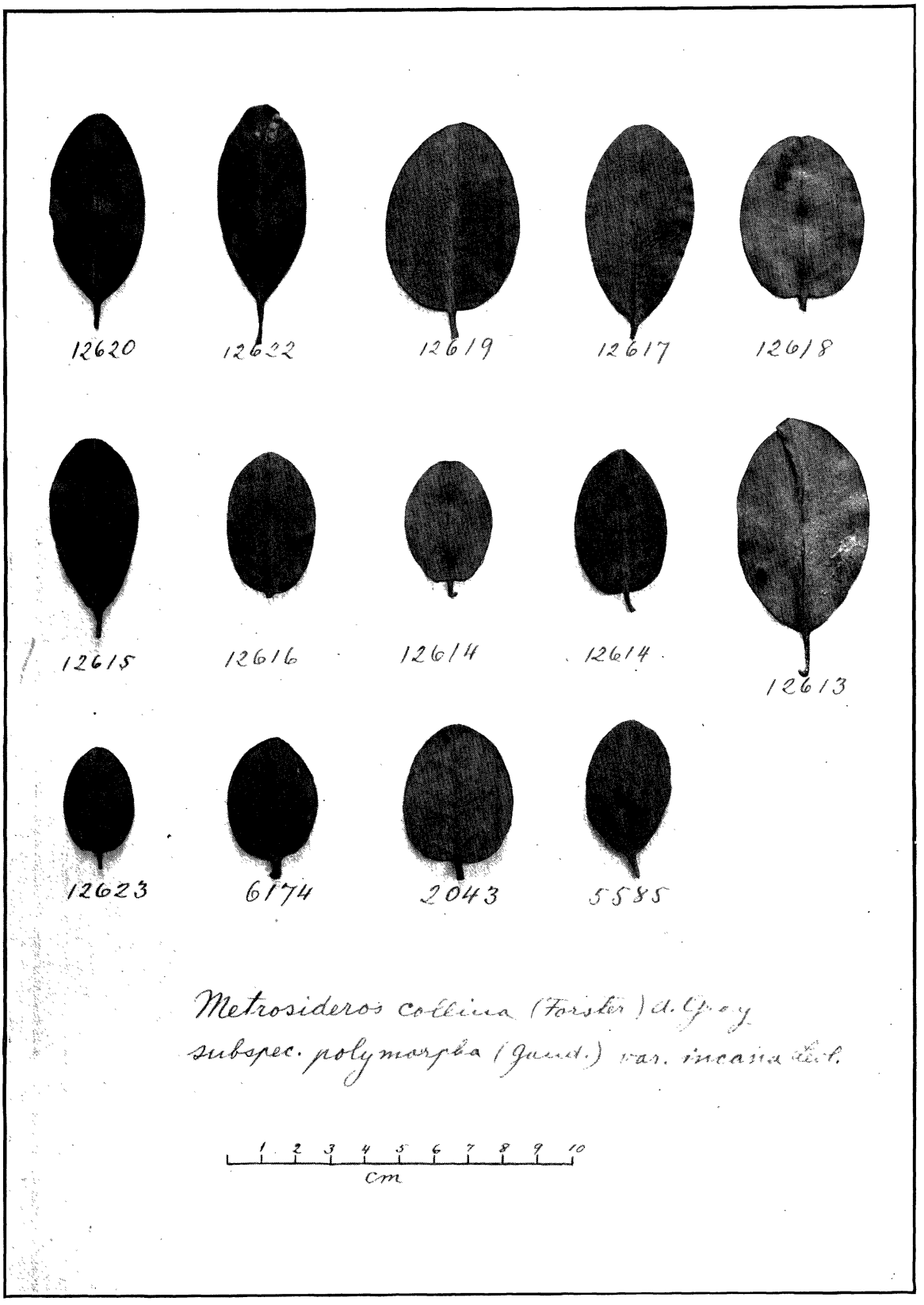
OAHU: Hillebrand, specimens not seen.
KAUAI: U. S. Expl. Exped.;—Lehua makanae swamps back of Kaholuamano, elev. 4200 feet, flowering March 3-10, 1909, Rock, No. 2043, and flowering and fruiting Sept. 6, 1909, No. 5885, in College of Hawaii Herbarium.
MOLOKAI: Hillebrand;—Waiau Gulch near Maunahui, flowering March 21, 1910, Rock, No. 6174 in College of Hawaii Herbarium;—Kamolo, June, 1910, U. Faurie, No. 28.
MAUI: U. S. Expl. Exped., Crater of Haleakala?;—Hillebrand, specimens not seen.
HAWAII: U. S. Expl. Exped., both near the coast and on Mauna Loa;—Kona, Puna and Hilo, Hillebrand;—Piihonua gulch and lava flow back of Hilo, flowering and fruiting Feb., 1916, Math. Newell, Nos. 12613 to 12623, inclusive;—Kipuka Puaulu, near Volcano, Kilauea, 4200 feet, flowering April 22, 1916, Rock, No. 12634 in College of Hawaii Herbarium;—Volcano Kilauea vicinity, flowering April 22, 1916, Rock, Nos. 12635 and 12636;—Kau, on 1868 smooth (pahoehoe) lava flow, flowering April 23, 1916, Rock, No. 12637, in College of Hawaii Herbarium.

Var. *incana* is the most common variety on the Island of Hawaii, where it forms the somber forests extending from Puna to the Volcano of Kilauea, Kau and Kona. It is the tallest variety in the Hawaiian Islands, sending up straight trunks their entire length, save at the very apex, having only very short branches along the main bole. It thrives on a-a (rough) lava as well as on pahoehoe (smooth) lava, in black cinder and rich decomposed volcanic soil, and is an epiphyte on tree ferns in the wet forests.

Var. *incana* is Hillebrand's var. ε and is included in Gray's var. β which embraces all the various tomentose forms found on Hawaii, with the exception of var. *Newellii*. It certainly comes close to Gray's var. β, which is var. α *typica*, with orbicular cordate leaves, in this treatise. Léveillé includes in his var. *incana* Hillebrand's var. α, β, and ε, which are all very closely related to be sure, but still distinct enough to be ranked as varieties. No. 12613 is the typical var. *incana*.

It is true that the validity of this variety is a little doubtful, as it seems to

PLATE XIX.



Showing leaf variation in the var. **incana**, the most common variety on Hawaii. Each leaf is from a different specimen and different locality.

Metrosideros collina (Forster) Gray Subsp. **polymorpha** (Gaud.) var. **incana** forma **lurida** Rock.

merge into var. *α typica;* it may be only a form of the latter, which differs from it in the heart-shaped, shortly-petioled, orbicular leaves.

The typical *Metrosideros collina* from Fiji, Society Islands, Tahiti and Kermadec Island, which does not at all differ in the localities mentioned above, and which is otherwise known as *Metrosideros villosa* Sm. is almost identical with the Hawaiian var. *incana,* if identical at all with any of the Hawaiian forms. The only difference is apparently the sessile flowers; in the Hawaiian var. *incana* the flowers are almost subsessile, the pedicels ranging from 1-5 mm.

Metrosideros collina (Forster) A. Gray subsp. **polymorpha** (Gaud.) var. **incana** (Lévl.) forma **lurida** Rock n. f.

A medium-sized tree, with robust branches and tomentose branchlets; leaves ovate to suborbicular, yellowish green, with a dull grayish tomentum on both surfaces when young, but soon glabrate with the exception of the petioles and lower portion of midrib, bluntly acute or rounded at the apex, truncate or cordate at the base, thick coriaceous with a distinct intramarginal nerve about 2 mm. distant from the margin and arising from the second pair of lateral nerves at the base of the leaf, 3-5 cm. long, 2-3.5 cm. wide, on stout petioles of about 5 mm.; inflorescence a many flowered, densely white-woolly cyme; calyx densely white villous including the acute lobes, petals and stamens sulphur-yellow turning brownish when dry, petals covered with a glandular pubescence, the margins whitish ciliate; stamens 2 cm.; style as long or little shorter; capsule not known.

MOLOKAI: In dry gulches above Kamolo, leeward side, in company with *Reynoldsia sandwicensis, Dracaena aurea, Nothocestrum latifolium,* and other sub-xerophytic vegetation, flowering April, 1910, Rock, No. 7021 in College of Hawaii Herbarium.

This yellow-flowered *Metrosideros* must be regarded as a form of var. *incana,* with which it has the tomentose leaves in common. The tomentum becomes deciduous at the maturity of the leaves; the latter are ovate and often cordate at the base. It is, however, mainly distinguished from var. *incana* by the large flowered cyme and sulphur yellow petals and stamens. It is a robust form inhabiting the dry rocky regions of Kamolo on the lee side of Molokai.

This is the form mentioned in the writer's Indigenous Trees of the Hawaiian Islands on page 331, under var. *θ* beginning with the fourth line of description from above "here also belongs a form," etc.

Metrosideros collina (Forster) A. Gray subspec. **polymorpha** (Gaud.) var. **Haleakalensis** Rock.

Metrosideros collina (Forster) A. Gray subspec. **polymorpha** var. **Haleakalensis** Rock n. v.

Metrosideros polymorpha Gaud. var. η Rock in Indig. Trees Haw. Isl. 331, Pl. 127. 1913.

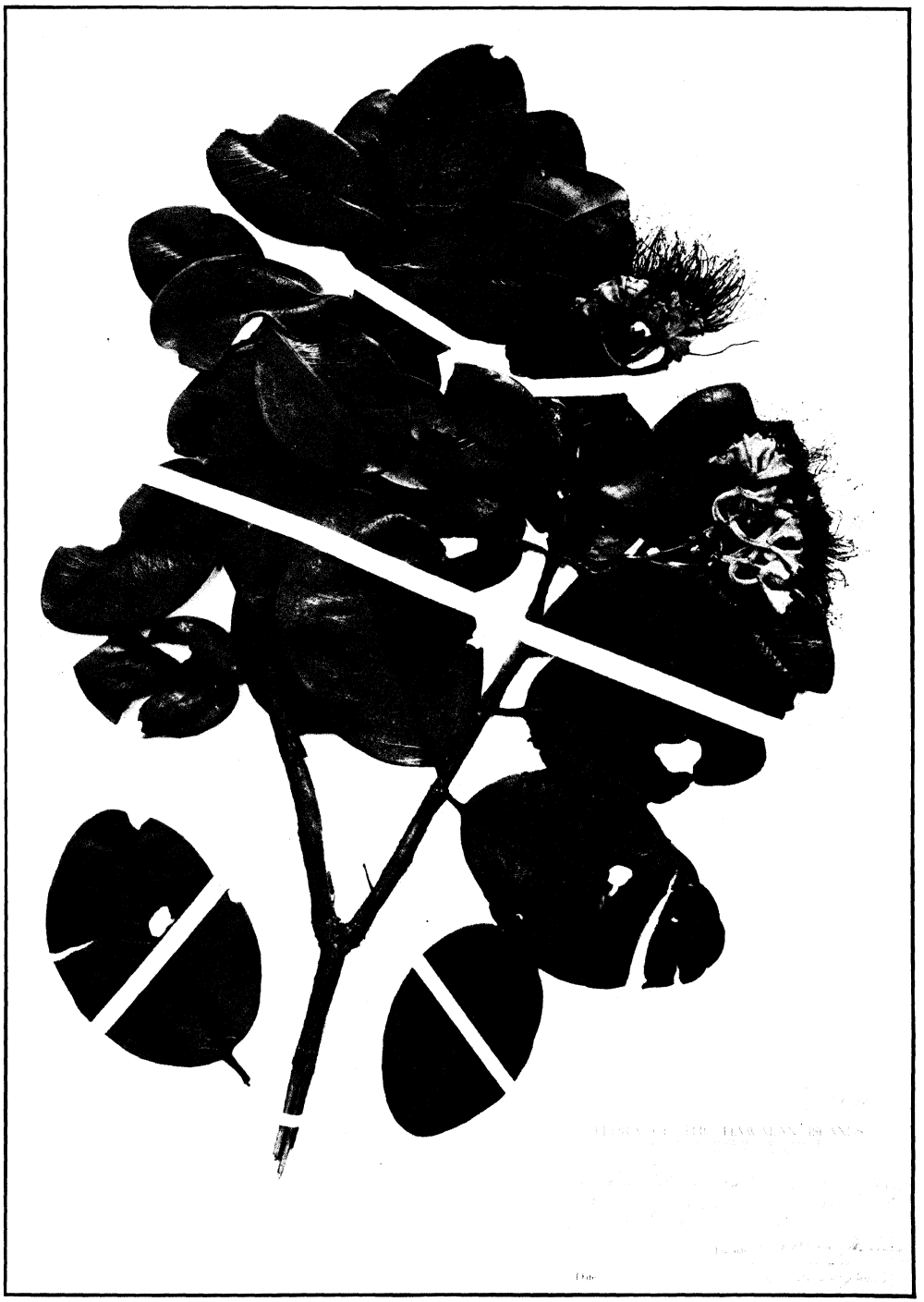
A tree 8-10 m. tall, freely branching, the branches rather brittle, stiff and stout; leaves thick, coriaceous, suorbicular to ovoid or obovoid, cordate at the base, rounded or slightly emarginate at the apex, subsessile, or shortly petiolate, perfectly glabrous on both sides, even when young, shining above, dull underneath, midrib prominent, the leaf-margin induplicate; cymes short, contracted, densely woolly; peduncle short; pedicels about 3 mm.; calyx densely white tomentose, the lobes green, glabrous; petals bright red, with white ciliate margins, rounded; stamens 2 cm., style exserted; capsule of a dirty gray, tomentose, large, 1 cm. in diameter.

MAUI: In gulches back of Puunianiau Crater, slopes of Mt. Haleakala, elevation 6500-7000 feet, flowering Oct., 1910, Rock, type No. 8593 in the College of Hawaii Herbarium.

A very handsome and distinct variety, reaching a height of 25 to 30 feet, with stiff, stout branches; it would come close to α *typica,* but differs from it in the thick, coriaceous, perfectly glabrous leaves and large flowers and capsules. It is near to Gray's var. γ, but differs from it in the densely woolly inflorescence and the large fruits. It does not belong to Hillebrand's var. δ, as he states: "glabrate in all parts"; but his specimen marked δ in the Gray Herbarium has a woolly inflorescence and, owing to the leaves, which are different from those of var. *Haleakalensis,* must be referred to the writer's var. *Newellii* Rock. Var. *Haleakalensis* is var. η, plate 127 in the Indigenous Trees of the Hawaiian Islands.

Gray's var. γ from the upper slopes (8000 feet) of Mauna Loa, Hawaii, (in the Gray Herbarium), while glabrous in all parts, will probably have to be referred to this variety, although the capsule is smaller and glabrous, the leaves are identical with var. *Haleakalensis.* It is possible that the capsules are quite old and have lost their tomentum. As the specimen in the Gray Herbarium is quite fragmentary, the question cannot be decided definitely.

This variety grows in company with *Raillardia Menziesii, Rubus, Lobelia, Argyroxiphium virescens* and *A. sandwicense* D.C. var. *macrocephalum.* It has apparently not been collected previously.



Metrosideros collina (Forster) A. Gray subs pec. **polymorpha** (Gaud.) var. **macrophylla** Rock n. v.

Metrosideros collina (Forster) A. Gray, subspec. **polymorpha** (Gaud.) var. **macrophylla** Rock, n. v.

A small tree 3-5 m. high, often bushy, with light brown terete branches and squamaceous bark; leaves large, thick coriaceous, bright green, glossy, shining above, dull underneath, with strong stout midrib, ovate in outline, obtuse at the apex, truncate or rounded at the base, or oblong and slightly acute at the apex, 8-12 cm. long, 5-8 cm. broad, on petioles of 10-18 mm.; cymes large, many flowered; flowers large, on pedicels of 4-6 mm.; calyx 6 mm., silky canescent, the lobes acute, deltoid, 3 mm., either pruinose or pubescent to glabrous; petals large dark red, 5 mm., rounded; stamens 25 mm. long, style as long; capsule large, resembling **M. macropus**, sikly canescent, almost included in the calyx tube, 8 mm. high.

HAWAII: Along the Volcano Road between Olaa and Mountain View, elevation about 1200-1500 feet, in wet forest, flowering and fruiting April 20-24, 1916, Rock, type 12630 in College of Hawaii Herbarium; other numbers collected, 12631 and 12632, belong here.

Var. *macrophylla* is an exceedingly handsome plant and very beautiful when in full flower. It is a small tree or shrub, and inhabits the wet forests of Olaa, Hawaii. It differs from all the other varieties in the exceedingly large leaves, flowers and capsules, but comes, otherwise, close to *M. collina polymorpha* var. *Newellii* of the low lands near Hilo.

Metrosideros collina (Forster) A. Gray, subspec. **polymorpha** (Gaud.) var. **Newellii** Rock n. v.

Metrosideros polymorpha Gaud. var. δ A. Gray, U. S. E. E., 562. 1854.

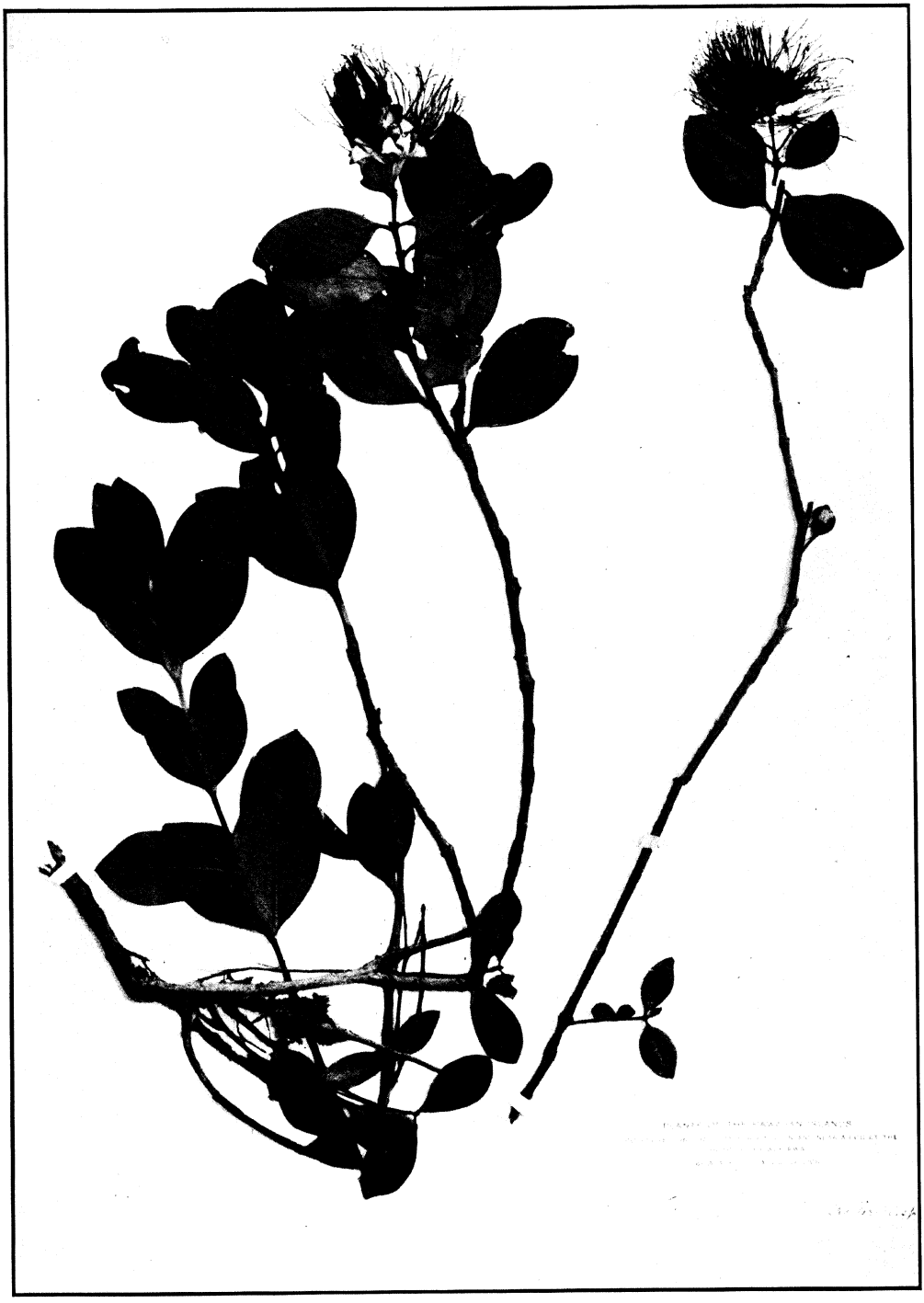
A shrub or small tree 4-8 m. high, with terete branches; leaves elliptical oblong to ovate, subcoriaceous, obtuse or acute at both ends, or slightly emarginate at the apex, glabrous on both sides, shining above, dull underneath, dark green, 4-7 cm. long, 2-3 cm. wide, on petioles of 6-10 mm., intramarginal nerve distinct, close to the margin; cyme small, densely white-woolly-tomentose; flowers small red, calyx white woolly, as well as calycine lobes, but occasionally glabrous; petals glabrous, slightly ciliate at the margins; stamens 22 mm., style as long or exserted; capsule small, dark gray and woolly, very much exserted from calycine tube.

HAWAII: Piihonua gulch, back of Hilo, flowering and fruiting, Feb., 1916, Brother Mathias Newell, Nos. 12625, 12626, 12627, 12628;—Piihonua gulch, flowering April 24, 1916, Rock, No. 12633 in College of Hawaii Herbarium;—Rainbow Falls, back of Hilo, flowering April 24, 1916, Rock, No. 12634 in College of Hawaii Herbarium.

This variety the writer named in honor of Bro. Mathias Newell of Hilo, who supplied him with material of several varieties of *Metrosideors,* and who took a keen interest in the work of straightening out the various forms of the Hawaiian *Ohias.* Var. *Newellii* is intermediate between var. *glaberrima* and var. *incana.* It differs from both of the latter varieties in having perfectly glabrous leaves and a woolly inflorescence, which fact brings it into the same category with var. *macrophylla,* which has the same characters in common with var. *Newellii,* but differs from it in the very large leaves, flowers and capsules, and in the latter being included in the calyx tube, while those of var. *Newellii* are very much exserted.

To this variety belongs Asa Gray's var. δ; Hillebrand is uncertain about this variety and refers it to γ or δ, but his var. δ is supposed to have a glabrous inflorescence. There is one specimen of this variety in the U. S. National Herbarium, No. 49427 ex Coll. U. S. Expl. Expedition.

Metrosideros collina (F.) A. Gray subsp **polymorpha** (Gaud.) var. **Newellii** Rock.



Metrosideros collina (Forster) A. Gray subsp. **polymorpha** (Gaud.) var. **pumila** (Heller) Rock.

Metrosideros collina (Forster) A. Gray, subspec. **polymorpha** (Gaud.) var. **pumila** (Heller) Rock.

Nani(a) pumila Heller in Minnes. Bot. Stud. IX: 864. Pl. 55. 1897.

Nania polymorpha Gaud. var. *glaberrima* Lévl. in part, in Fedde Repert. Spec. Nov. X: 149. 1911.

*A bush, 3 dm.-6 dm. high, either simple or sending out one or two ascending branches; outer bark gray, peeling off in shreds; leaves (orbicular?), broadly ovate, or sometimes obovate, the largest about 5 cm. in diameter, thick glabrous, light green and shining above, dull and glandular underneath, the margin lightly induplicate, midrib impressed above, prominent beneath; petioles stout about 6 mm. long; fully developed cymes large, with densely woolly peduncles 2.5 cm. in length; calyx very woolly, except the short, triangular lobes, which are almost glabrous, but glandular; petals red, broadly obovate, about 6 mm. in length, glandular on the outside, ciliate; stamens numerous 2.5 cm. long, dark red; style almost as long, not enlarged at the stigmatose apex; ovary deeply immersed in the bottom of the calyx, its disk-like top very glandular and resinous.

KAUAI: On and near the bog at the head of the Wahiawa River, at an elevation of 3000 feet, flowering Aug. 21, 1895, Heller, type No. 2738 in Gray Herbarium.

The writer has not collected this variety, which seems quite distinct from the other swampy forms found on Kauai, Molokai, Maui and Hawaii. Heller, in his description, says orbicular, the writer enclosed the word in the parenthesis and placed a query mark after it. The leaves in Heller's plate in the type number are not orbicular, but ovate, and tapering at the base and are perfectly glabrous.

In the swamps of Lehua makanoe and Alakai occurs a form with orbicular or ovate leaves which are woolly underneath and were placed by the writer with var. *incana*.. Heller's statement that his *pumila* is also confined to the large bog on the plateau above Waimea, is incorrect. The low form which occurs in that bog belongs to var. *incana*. Not even the variety found at the summit of Waialeale, Kauai, has anything in common with variety *pumila*.

Metrosideros collina (Forster) A. Gray subspec. **polymorpha** var. **prostrata** Rock.

Metrosideros polymorpha Gaud. var. γ Hbd. Flora Haw. Isl. 126. 1888.

Metrosideros polymorpha Gaud. var. α et ε Rock, Indig. Trees Haw. Isl. 327. 1913.

Plant prostrate, trailing, 10-30 cm. high, or entirely prostrate and 1-2 m. long, branches and branchlets quadrangular, the latter reddish, leaves as in variety α **typica**, though smaller except in the Kauai specimen, 15 mm.14 cm. long, 10 mm.-3 cm. wide, suborbicular to ovate, cordate to subcordate to rounded at the base, bluntly acute or rounded at the apex, coriaceous, glabrous on both sides (with the exception of the Waialeale, Kauai, specimens, which are slightly pubescent above when young), shining above, dull underneath, the margins slightly induplicate, midrib prominent underneath, intramarginal nerve indistinct or arched and uniting the lateral veins; cymes few flowered, white woolly, or glabrous when older, or slightly silvery canescent; calyx woolly with the exception of the calycine lobes; petals red as well as the stamens, the former with whitish ciliate margins; stamens 2-2.5 cm. long, style as long or longer; capsule not known.

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*Heller's original description is here quoted, only part of the measurements have been changed into the metric system, and description which belongs to generic character omitted.

Metrosideros collina (Forster) Gray, subsp. **polymorpha** (Gaud.) var. **prostrata** Rock.

Metrosideros collina (Forster) Gray subspec. **polymorpha** (Gaud.) var. **prostrata** forma **strigosa** Rock

KAUAI: Summit swamp of Mt. Waialeale, elevation 500-5200 feet, flowering Sept. 24, 1909, in company with *Dubautia Waialealae, Geranium humile,* var. *kauaiense, Drosera longifolia, Orcobulus furcatus, Sanicula,* etc., Rock, No. 5087 in College of Hawaii Herbarium.

MOLOKAI: Kawela swamps back of Kamoku, flowering March 17, 1910, in company with *Astelia, Viola mauiensis, Styphelia,* etc., Rock, No. 6097 in College of Hawaii Herbarium.

MAUI: In the bogs on the top of Eeka, Hillebrand, in Berlin and Gray Herbarium;—summit of Mt. Puukukui, West Maui, elevation 5800 feet, flowering Aug., 1910, in company with *Sanicula, Acaena glauca, Viola mauiensis, Wilkesia grayana, Geranium humile,* Rock, No. 8145 in the College of Hawaii Herbarium.

This variety is quite dis tinct from Heller's var. *pumila,* and is identical with Hillebrand's var. γ from West Maui. The specimens from Waialeale, Kauai, may be looked upon as an intermediate between var. *prostrata* and *pumila,* though the latter has no prostrate habit, which may, however, be due to the lower elevation.

Var. *prostrata* occurs on Kauai, Molokai and Maui, while a very strigosely hispid form of it can be found on the summit swamp of the Kohala Mountains on Hawaii. The specimens from the West Maui Puu Kukui swamp has glabrous cymes, which fact accounted for the writer's separating it from the others in his treatise on that genus in the Indigenous Trees of the Hawaiian Islands, and his placing it in the section *glabrae* var. α.

The West Maui and Molokai specimens are practically identical, while the Kauai specimens differ slightly, and that only in the leaves, which in the latter have a slightly tomentose midrib. The tomentum on the cyme cannot be relied upon in this variety, as I have found densely woolly inflorescences and only fine silky-canescent ones on the same plant. Hillebrand's specimen of his var. γ in the Gray Herbarium is only slightly tomentose, while he says in his description "woolly-tomentose."

Metrosideros collina (Forster) A. Gray, subspec. **polymorpha** (Gaud.) var. **prostrata** forma **strigosa** Rock.

Metrosideros polymorpha Gaud. var. κ Rock, Indig. Trees, Haw. Isl. 331. 1913.

Plant small, prostrate, about 20 cm. in length; leaves orbicular, or obcordate, broadest at the apex, cordate at the base and often subcordate at the apex, or deeply marginate, 15-20 mm. in diameter, glabrous above when old, covered with a grayish tomentum when young, densely strigose with yellowish hair underneath, coriaceous, the margins induplicate, petioles very short 1-2 mm.; cyme very short, few flowered, densely villous; calyx and calycine lobes as well as ovary villous; petals red, pubescent outside; stamens red, 2 cm. long, style as long, stigma pubescent; capsule unknown.

HAWAII: In bog on summit of Kohala Mountains in company with *Viola mauiensis* var. *Kohalana, Selaginella deflexa,* etc., flowering June, 1910, Rock, No. 8414 type in College of Hawaii Herbarium.

An interesting form of var. *prostrata* differing from it in the obcordate subsessile leaves, which are densely strigose underneath. It is peculiar to the summit of the Kohala Mountains, where it grows prostrate in the open bog which harbors a similar vegetation to that of Puu Kukui, Maui and Waialeale of Kauai.

NOTE.—The Kauai plants inhabit open spots of bright red (oxidized) soil or clay, which the natives of bygone days employed for painting their canoes and other objects.

Metrosideros collina (Forster) Gray subspec. **polymorpha** (Gaud.) var. **Fauriei** (Levl.) Rock.

Metrosideros collina (Forster) A. Gray subspecies **polymorpha** (Gaud.) var. **glabrifolia** (Heller) Rock.

Metrosideros collina (Forster) A. Gray, subspec. **polymorpha** (Gaud.) var. **Fauriei** (Lévl.) Rock.

x *Nania* (*Metrosideros*) *Faurici* Lévl. in Fedde Repert. spec. nov. X: 150. 1911.

A medium-sized tree about 10 m. or less high, many branched; branches terete, branchlets slightly quadrangular, glabrous, reddish; leaves linear-oblong, bluntly acute or obtuse at both ends, light green, with reddish midrib, resembling **M. tremuloides,** thick coriaceous, dull on both sides, 4-7 cm. long, 1-2.5 cm. wide, on rather long petioles of 1-2 cm.; inflorescence a many-flowered cyme, silky canescent or woolly; calyx woolly or subglabrous, the acute lobes glabrous; petals red, minutely ciliate on the margines; stamens about 2 cm., style exserted 2.5 cm. in length, capsule glabrous, rather large, almost entirely hidden in the calyx.

MOLOKAI: Kamalo, June, 1910, U. Faurie;—middle ridge of Mapulehu, elevation 1500 feet, flowering Dec. 28, 1915, Rock and Copeland, No. 12524 in College of Hawaii Herbarium.

This variety, which was described or rather mentioned as a hybrid of *M. polymorpha* and *M. macropus* by H. Léveillé, has only the rather long petioles in common with the latter species; to be more correct the petioles, which are rather long for a variety of the subspecies *polymorpha,* approach in length those of *M. macropus.* In shape of leaf it comes close to *M. tremuloides,* and var. *glaberrima* of *polymorpha,* but differs from either in the woolly inflorescence. The included capsule (in calyx) and the rather long petioles, are responsible for Léveillé's placing it as a hybrid of *M. macropus;* however, in the latter species the petioles are much longer and the inflorescence is evolved from a scaly bud, the scales remaining persistent. In var. *Faurici* small scales are noticeable, but are attached at the base of the calyx only and become soon deciduous. The scales in *M. macropus* are not at the base of the calyx, but at the base of the pedicels and at the base of a foliose flower bearing branchlet. This factor throws var. *Faurici* out of possible varietal rank of *Metrosideros macropus.* It grows on open grassy slopes on the lower ridges on the leeward side of Molokai in company with var. *glaberrima.*

Metrosideros collina (Forster) A. Gray, subspec. **polymorpha** (Gaud.) var. **glabrifolia** (Heller) Rock.

Nani(a) glabrifolia Heller in Minnes. Bot. Stud. IX: 866: 1897.

*A large tree 10-14 m. in height, with a trunk diameter of 6.5 dm.-1.6 m.; main branches stout and spreading, young branches crowded, angled, with short internodes; leaves numerous, broadly ovate, usually cordate at the base on very short petioles, glabrous; the short, stout, peduncles and pedicels as well as the calyx shortly pubescent, but not woolly; fruit three-fourths free; flowers bright red.

KAUAI: On the high plateau of Waimea, Kaholuamano, elevation 4000 feet, fruiting Sept. 10-16, 1895, Heller, type No. 2821.

This variety was not collected by the author; it is quite distinct and comes probably close to var. *glaberrima* (Lévl.) Rock, but differs from it in the small ovate-cordate leaves and stout branches. The leaves would remind one of var. γ of Gray, but are not so thick in texture.

*Heller's original description is quoted, only the measurements have been changed into the metric system.

Metrosideros collina (Forster) Gray subspec. **polymorpha** (Gaud.) var. **glaberrima** Levl.

Metrosideros collina (Forster) Gray subsp. **polymorpha** (Gaud.) var. **glaberrima** (Lévl.) Rock.

Metrosideros polymorpha Gaud. Bot. Voy. Uranie, 482, Pl. 109. 1826.

Metrosideros polymorpha Gaud. var. ζ Gray in part.

Metrosideros polymorpha Gaud. var. γ et var. *lutea* H. Mann in Proc. Am. Acad. VII: 166. 1866.

Metrosideros polymorpha Gaud. var. 2, 5 et 7 *lutea* H. Mann in Proc. Ess. Inst. 5: 243-244. 1868.

Metrosideros polymorpha Gaud. var. ζ Hbd. Flora Haw. Isl. 127. 1888.

Nani(a) lutea Heller (not A. Gray) in Minnes. Bot. Stud. IX: 867. 1897.

Nania polymorpha Gaud. var. *glaberrima* (Lévl.) in Fedde Repert. Spec. nov. X: 149. 1911.

Metrosideros polymorpha Gaud. var. γ Rock, Indig. Trees Haw. Isl. 327. 1913.

Medium-sized or tall trees 10-15 m. high, perfectly glabrous in all parts, branches and branchlets terete; leaves ovate, elliptic, oblong, or obovate, rounded, obtuse or acute at both ends, chartaceous to coriaceous, glabrous on both sides, 3.5-7.5 cm. long, 1.5-3.5 cm. wide, on petioles of 3-10 mm., intramarginal nerve distinct in the larger leaved specimens; cyme perfectly glabrous, many and large flowered, calyx glabrous as well as calycine lobes and petals, the former thin with reddish, thinner margins, the latter oblong, red to salmon-pink, usually not ciliate on the margins or only slightly so, capsules glabrous.

OAHU: Woahoo, Ins. Sandwich, Maio, 1825, Macrae, in Gray Herbarium;—Gaud. Voy. Bonite, in Gray Herbarium;—U. S. Expl. Exped. 1838-42, in Gray Herbarium;—Oahu, Mann and Brigham, 96 in U. S. National Herbarium, No. 49433;—lower slopes of Konahuanui, above Manoa, flowering April 25, 1895, Heller, No. 2219 in Gray Herbarium;—Waianu Valley, near Waiahole, flowering Jan. 22, 1909, Rock, No. 1177;—Mts. of Wahiawa, flowering July, 1908, No. 134 in the College of Hawaii Herbarium;— Konahuanui trail, flowering Jan. 7, 1909, No. 1010;—Waikane Mts., windward side, flowering Jan. 23, 1909, No. 1278, College of Hawaii Herbarium;—Kaliuwaa Valley, flowering Aug. 15, 1908, No. 134 in College of Hawaii Herbarium.

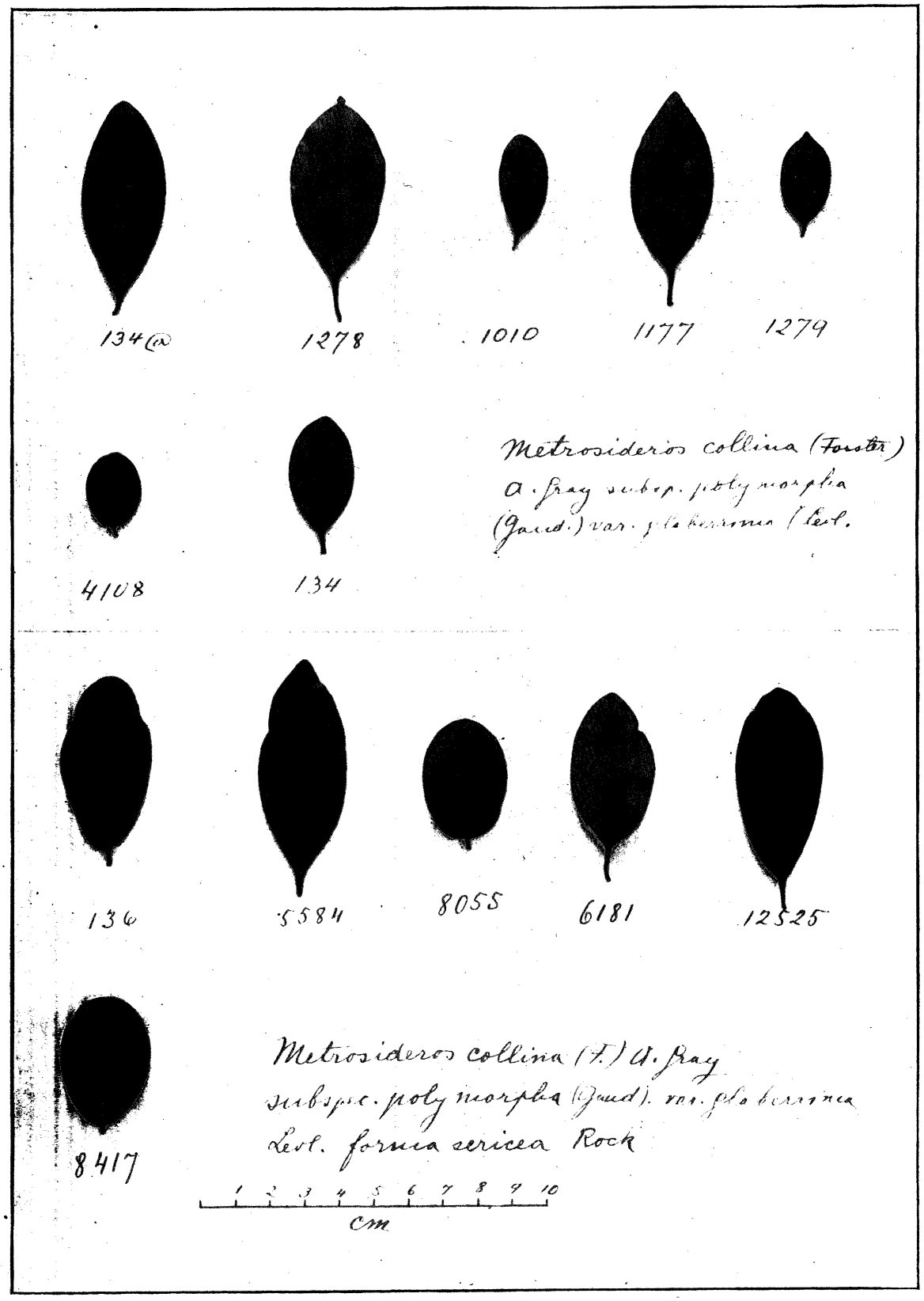
KAUAI: Along the Hanapepe River near the falls, flowering July 2-8, 1895, Heller, No. 2484 in Gray Herbarium, and U. S. National Herbarium No. 265134.

HAWAII: Woods above Waimea, wet forests, flowering July 9, 1909, Rock, No. 4108 in College of Hawaii Herbarium.

This is one of the most commonly-met-with varieties on Oahu, while on Hawaii the woolly forms are more common. This variety embraces various leaf forms from ovate and rounded to oblong and acute forms; only in the very young flower buds can there be a fine silkiness detected, the mature flowers are, however, perfectly glabrous. The pruinose form (*sericea*) seems to be a transition type leading to var. *Newellii* from Hilo, Hawaii, while the very glabrous form with small leaves leans towards *M. tremuloides*. On Oahu this tree grows straight with erect main bole when in open stands, and reaches a height of 40-45 feet, but when growing on ridges and in forests with other trees has a short trunk branching several times a few feet above the ground.

Var. *glaberrima* is Gaudichaud's plate 109, Bot. Voy. Uranie. To it be-

PLATE XXX.



Leaf variation of variety **glaberrima** and its form **sericea.**

longs Mann and Brigham's No. 212 from Oahu, marked *M. polymorpha* var. *lutea*. A collector by the name of Mathews gathered a specimen in the Society Islands in 1830, No. 50, which he describes as a shrub 5 feet in height growing on high hills, seems to belong to forma *sericea* of this variety or, which is more likely, to *Metrosideros collina* var. γ *viticnsis*, regarding which see under forma *sericea*. A. Gray's var. *glaberrima* of *Metrosideros collina* certainly seems, or rather is, exceedingly close to var. *glaberrima* of its subspecies *polymorpha*, for even the fruits which are supposed to be sessile in *M. collina* are distinctly pedicellate in his specimen.

In the Society Islands, or the South Pacific Islands as a whole, there seems to be much less variation in the species than in the Hawaiian subspecies, various forms of which seem to link varieties of the species *collina* together. *Metrosideros collina* var. *villosa* (*M. villosa*) from Fiji is absolutely identical with plants from Tahiti. In the latter island there are apparently only three or four forms: 1. *glaberrima*, a perfectly glabrous form close to *glaberrima* of the subspecies *polymorpha*; 2. a pruinose form (var. γ *viticnsis*) close to forma *sericea* of the Hawaiian var. *glaberrima*; 3. var. α *villosa*, the typical *M. collina* which is close to our var. *incana*. There is a fourth variety of Seeman (No. 171) from Fiji which is exceedingly close to *M. tremuloides* of Oahu, Hawaii.

All the other remaining varieties and forms described from Hawaii are peculiar to the group, and have apparently no affinities to South Sea Island forms of *M. collina*, on which fact our subspecies *polymorpha* is based. The very small leaved specimens of this variety are almost sufficiently distinct to make it a form of var. *glaberrima* (Lévl.) Rock.

Metrosideros collina (Forster) A. Gray, subspec. **polymorpha** (Gaud.) var. **glaberrima** (Lévl.) forma **sericea** Rock.

Metrosideros polymorpha Gaud. var. ε A. Gray. U. S. E. E. 563. 1854.

Metrosideros polymorpha Gaud. var. δ Hbd. in part. Flora Haw. Isl. 126. 1888.

Metrosideros polymorpha Gaud. var. δ Rock (non. Hbd.) et θ Rock in Indig. Trees Haw. Isl. 327 et 331. 1913.

Medium-sized trees with angular or slightly flattened reddish branchlets, leaves ovate, elliptical, or ovate-oblong, bluntly acute or rounded at both ends or subcordate at base, dull or glossy on both sides, glabrous, or the midrib slightly tomentose underneath (only in No. 8417 from Hawaii), intramarginal nerve distinct, arising from the second lateral pair at the base, chartaceous to coriaceous, 3-7 cm. long, 1.5-3.5 cm. wide, on petioles of 2-6 mm.; cyme short and few-flowered to open and many-flowered, pruinose to slightly silky, silvery pubescent, ultimate pedicels varying from 1.5-3 mm.; calyx pruinose or silky canescent, excepting the obtuse lobes; petals and stamens from pink and salmon colored to deep red, the petals glabrous; capsule pruinose, exserted.

KAUAI: Between the Hanapepe and Wahiawa rivers, flowering June 22-Aug. 24, 1895, Heller, Nos. 2762, 2690, 2417 in Gray Herbarium;—on the trail to Waialae Falls, Kaholuamano, elevation 3400 feet, flowering Sept., 1909, Rock, No. 5584 in College of Hawaii Herbarium.

OAHU: In the mountains behind Honolulu and Waianae, U. S. E. E.;—Wahiawa, north fork of Kaukonahua gulch, flowering May 15, 1909, Rock, No. 136 in College of Hawaii Herbarium;—along Tantalus, flowering April 2, 1895, A. A. Heller, No. 2053, in the U. S. Nat. Herb. No. 262854.

PLATE XXXI.

Metrosideros collina polymorpha var. **glaberrima.**
Trunk of the glabrous form of **Ohia Lehua,** growing on Kauai, Kaholuamano, elevation 3600 feet.

MOLOKAI: Mapulehu ridge, flowering Dec. 28, 1915, Rock, No. 12525 in College of Hawaii Herbarium, and Waiau Valley, March 28, 1910, No. 6181 in College of Hawaii Herbarium.
LANAI: Mahana ridge, flowering July 22, 1910, Rock, No. 8055.
HAWAII: Byron Bay, July, 1825, Macrae, in Gray Herbarium;—mountains of Mauna Loa?, Hbd.;—lowlands of Kohala, flowering June, 1910, Rock, No. 8417 in College of Hawaii Herbarium.

The form *sericea* of var. *glaberrima* is identical with Asa Gray's var. ε and Macrae's var. ε, and is in part Hillebrand's var. δ and ζ. It also includes the writer's variety δ from Molokai, and var. θ from Lanai. This form differs mainly from var. *glaberrima* in the pruinose or silky canescent cyme and calyx. It is almost identical with Asa Gray's *Metrosideros collina* var. γ *viticnsis* of which he says: "*ramulis foliisque ellipticis oblongisve glabris; inflorescentia calycibusque plus minus cano-sericeis; floribus nunc subpedicellatis.*" He further says in his discussion: "Flowers sessile or nearly so, etc., which distinguishes the plant from the Sandwich Islands." The writer has in his possession plants from the Island of Hawaii which have pedicels shorter than those in var. γ *viticnsis* of Asa Gray, and again, there is a specimen from Fiji collected by W. H. Harvey in Nov., 1885, in the Gray Herbarium which A. Gray must have seen, which has glabrous leaves and a woolly inflorescence and which has pedicels 4 mm. long, also as long as, and longer than those found in Hawaiian specimens. Were it not for avoiding confusion, and for the fact that this plant, strangely identical with a Fijian variety, is simply a form of a very polymorphous subspecies of *Metrosideros collina*, which links together a large number of varieties, and which in itself is again represented by numerous subforms which cannot be separately enumerated, but are included in the general description, the writer would unite it with Gray's var. γ *viticnsis*, which is merely one of three varieties of the *Metrosideros collina* occurring in Fiji.

Strangely, Asa Gray laid too much stress on the length of pedicels, which are sometimes wanting, or oftener wanting than present, but are nevertheless very distinct, and as already mentioned, are 4 mm. long in some Fijian material; he had a splendid opportunity to save confusion in taxonomy and could have straightened out this perplexing species.

The only possible difference between the Hawaiian forma *sericea* and var. γ *viticnsis* from Fiji is the size of the flower, which is a little smaller in the Fijian plant, the shape of leaf is also slightly different in being acute at both ends, but were one to pay too much attention to leaf-forms one would have to describe nearly every *Metrosideros* tree in the Hawaiian Islands.

Heller's No. 2762 labeled *Nania macropus* is the closest specimen to var. γ *viticnsis*, the flowers are exactly of the same size and the pedicels 1 mm. in length, only the leaves are on slightly longer petioles. It has nothing in common with *Metrosideros macropus*, and must be referred to *Metrosideros collina* forma *sericea*. Here also belongs Heller's No. 2690, with subcordate leaves, and No. 3417, both from Kauai, between the Hanapepe and Wahiawa rivers.

REMARKS

In the Herbarium Hortus Botanicus Bogoriensis (Botanic Gardens, Buitenzorg, Java) are the following sheets of *Metrosideros:*

1. *Metrosideros collina* (F.) Gray, var. γ *vitiensis* Gray, collected by J. Horne, 1877-1878, in Fiji Islands, No. 863, and was originally labeled *Metrosideros polymorpha.*
2. *Metrosideros villosa* Smith (originally labeled *M. polymorpha*), referable to *Metrosideros collina,* collected by Fullagar on Lord Howe's Island. The flowers are pedicellate and silky canescent, the capsule is large oblong; the leaves glabrous, thick and leathery, veins prominent on both sides.
3. Another specimen collected by Reinecke in Tutuila: Lepiva, Samoa, in December, 1894, No. 643; referable to *Metrosideros collina,* is a small leaved form of the type of the Hawaiian small leaved var. *glaberrima;* the fruits (immature?) are very small.

Besides the specimens referable to *M. collina* (F.) Gray the following are also represented:

1. *Metrosideros ternifolia* F. v. M. Queensland, ex Museum of Melbourne; the leaves are needle-like, flowers small.
2. *Metrosideros porphyrea* Schlechter from New Caledonia, collected by Mme. Le. Rat, 9 October, 1909, No. 33. Leaves small, corymbs short, flowers very small and subglabrous.
3. *Metrosideros ramiflora* Lauterbach from New Guinea, collected by Von Ritmers, November 6, 1909, No. 838. Det. as new species by C. Lauterbach. (The plants are from Nederlandish, New Guinea.)
4. *Metrosideros operculata* Lab. from New Caledonia, collected by M. Pancher in 1870.
5. *Metrosideros Engleriana* Schlechter, a shrub 6-10 feet in height, growing on the slopes of Mt. Ngoye, 2400-3600 feet elevation, in New Caledonia, collected November, 1902, by R. Schlechter.
6. *Metrosideros leptopetala* F. v. Mueller, collected in November, 1896, at Port Jackson, N. S. Wales, Australia.
7. *Metrosideros nervulosa* C. Moore et F. v. Mueller, from Lord Howe's Island.

The manuscript of this paper was already in the printer's hands when the writer received a package containing specimens of species of *Metrosideros* deposited in the United States National Herbarium, through the courtesy of the authorities of the Smithsonian Institute, to whom the writer wishes to express his sincere thanks. The specimens represent mostly plants collected in Hawaii and in the South Sea Islands, by the U. S. Exploring Expedition and later collectors. Some of them are duplicates of those in the Gray Herbarium.

The following here enumerated are of immediate interest:

No. 49423=*Metrosideros collina* var. *glaberrima* from Tahiti; Coll. U. S. Expl. Exped.

Nos. 340568=Referable to *Metrosideros collina* var. γ *vitiensis* Gray. Collected 341969 by Dr. Reinecke, No. 643, in Tutuila;—Lepiva, Samoa, in December, 1894.

No. 239500=*Metrosideros collina* var. *glaberrima* collected by M. Bidwill in the Society Islands; ex Herbarium Hookerianum (1867). (Without name.)

No. 652926=*Metrosideros collina* var. *villosa* A. Gray. Coll. by J. E. Tilden in Papeari, Tahiti, Society Islands, Oct., 1909. The plant is labeled: 61. *Metrosideros villosa* Sm.

No. 49422=Identical with No. 652926; Coll. U. S. Expl. Exped. in Tahiti.

No. 49424=*Metrosideros collina polymorpha* var. *glaberrima*. Coll. U. S. Expl. Exped. on Oahu, labeled *Metrosideros polymorpha* ζ Gray.

No 49426=*Metrosideros collina polymorpha glaberrima* f. *sericea* Rock, Coll. U. S. Explor. Exped., labeled *Metrosideros polymorpha* var. ε.

No. 265134=*Metrosideros collina polymorpha* var. *glaberrima*, Coll. A. A. Heller, No. 2484, Hanapepe River, Kauai, July 2-8 1895.

No. 49427=Two specimens on one sheet, representing two different varieties of *Metrosideros collina polymorpha;* the right-hand one is the writer's var. *Newellii*, the left one is doubtfully referred to var. *glaberrima*. Coll. U. S. Expl. Exped. Sandwich Islands; labeled *Metrosideros polymorpha* var. δ.

No. 49428=One sheet with two different specimens of *Metrosideros;* the left-hand one is the writer's var. *Haleakalensis*, while the right-hand one is var. α *typica* with heartshaped tomentose leaves (marked var. γ Gray). Coll. U. S. Expl. Exped. Sandwich Islands.

No. 49429=Leaf specimen only is var. *incana*, marked *Metrosideros polymorpha* near var. β from Puna, Hawaii. Coll. U. S. Explor. Exped.

No. 265488=*Metrosideros tremuloides* (Heller) P. Knuth. Heller's No. 2895, *Nania tremuloides*, Oahu, Nuuanu Pali, Oct. 29, 1895.

No. 265505=*Metrosideros collina polymorpha* var. α *typica*. Heller's spec. of *Nania polymorpha* (Gaud.), May 28, 1895, slopes of Konahuanui above Manoa.

No. 262854=*Metrosideros collina polymorpha* var. *glaberrima* f. *sericea*=Heller No. 2053, *Metrosideros polymorpha*. Oahu, along Tantalus, April 2, 1895.

No. 264091=*Metrosideros collina polymorpha* var. *glaberrima*=Heller's No. 2219. Konahuanui, above Manoa, April 25, 1895.

No. 265169=*Metrosideros collina polymorpha glaberrima* f. *sericea*=Heller's No. 2417 *Nania*. July 18, 1895, between the Hanapepe and Wahiawa rivers.

No. 239501=*Metrosideros collina polymorpha* var. α *typica*. Ex Herb. Hookerianum (1867). Coll. by Macrae on Owhyhee.

No. 262528=*Metrosideros collina polymorpha glaberrima* f. *sericea* Rock = Heller's 2690. Aug. 24, 1895, Hanapepe and Wahiawa rivers. *Nania* ——.

No. 262813=*Metrosideros collina polymorpha glaberrima* f. *sericea*=Heller's 2762. Aug. 24, 1895. Labeled *Nania macropus.*

No. 49431=*Metrosideros collina polymorpha α typica.* Coll. U. S. Expl. Exped. Marked *Metrosideros polymorpha* var. β Gray, Hawaii.

No. 49432=*Metrosideros collina polymorpha α typica,* marked "form of *M. polymorpha α*" Hawaii. (This is the Oahu form of *α typica.*— Writer.) Ex Herb. U. S. Explor. Exped.

No. 49433=*Metrosideros collina polymorpha* var. *glaberrima*=Mann & Brigham No. 96, Oahu.

No. 49421=*Metrosideros macropus* H. et A. Ex Herb. U. S. Expl. Exped. Sandwich Islands.

No. 49434=*Metrosideros collina polymorpha* var. *imbricata,* labeled *Metrosideros polymorpha* var. α; ex Herb. U. S. Expl. Exped., Oahu.

No. 712986=*Metrosideros collina polymorpha* var. *glaberrima* ex Herb. Bureau of Science, Manila. Coll. H. M. Curran, April, 1911. *Nania, metrosideros polymorpha.*

No. 49430=This sheet contains two different specimens; the lower one is rather peculiar and is marked *Metrosideros polymorpha* var. verging to β. Coll. Kauai, U. S. Expl. Exped. It certainly comes close to var. *α typica* but the leaves are very large, somewhat subcordate or rather truncate, they are glabrous on both sides save for a grayish pruinose pubescence on the thickened petiole which merges into thickened and broad midrib; the capsule is large, grayish tomentose and immersed in the calyx. It cannot be placed satisfactorily, but it comes closest to var. *α typica* and may be known as forma *crassinervis.* No. 49425 seems to belong here too, having the pubescent petiole in common with No. 49430. Both may be referable to var. *glabrifolia* (Hell.) Rock. No. 49425 is labeled *Metrosideros polymorpha* var. inter β et ε. Sandwich Islands.

Among the collections made by A. L. Hitchcock during the summer months of 1916, are the following numbers of **Metrosideros:** 13794 and 13773=**M. tremuloides;** 14839=**M. coll. polym.** var. **prostrata** from West Maui; 15051=**M. coll. polym.** var. **glaberrima** forma **sericea** from Pukoo, Molokai; 14404=**M. coll. polym.** var. **macrophylla** from Waimea, Hawaii. Of special interest is No. 15176 which is **M. coll. polym.** var. **prostrata** f. **strigosa** from the swamps of Molokai. Nos. 14980 from Haleakala Crater and 15587 from Mt. Hualalai, Hawaii, belong to **M. coll. polym.** var. *α* **typica,** as well as 14633 from Mauna Loa, Hawaii.

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BOTANICAL BULLETIN No. 5. AUG 20 1919 JUNE, 1919

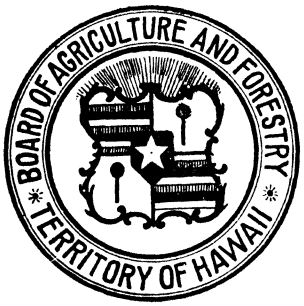
Territory of Hawaii
BOARD OF AGRICULTURE AND FORESTRY

DIVISION OF FORESTRY
C. S. JUDD, *Superintendent*

The Arborescent Indigenous Legumes of Hawaii

BY

JOSEPH F. ROCK
Consulting Botanist



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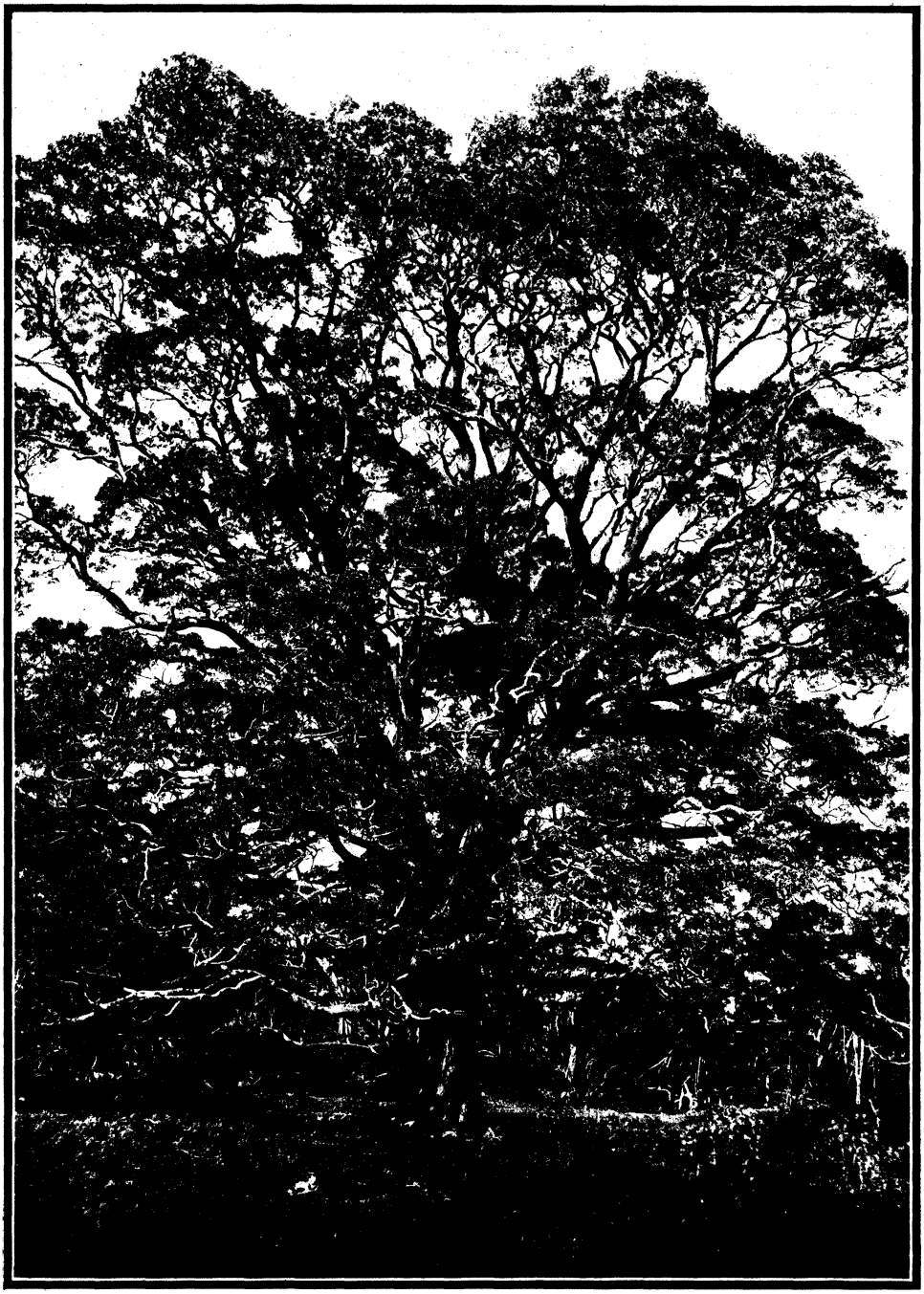

ACACIA KOA HAWAIIENSIS Rock
Koa.

Tree about 80 feet tall, with diameter of trunk about 4 feet; growing in the Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet.

BOTANICAL BULLETIN No. 5. JUNE, 1919

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The Arborescent Indigenous Legumes of Hawaii

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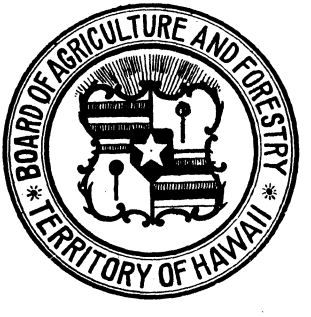

ISSUED JUNE 9, 1919
HONOLULU, HAWAII

LETTER OF TRANSMITTAL.

HONOLULU, HAWAII, Feb. 24, 1919.

Board of Commissioners of Agriculture and Forestry,
Honolulu, Hawaii.

GENTLEMEN:

I have the honor to transmit herewith the manuscript of a paper entitled "The Arborescent Indigenous Legumes of Hawaii," by Mr. Joseph F. Rock, *Consulting Botanist of the Division of Forestry* and also *Botanist of the College of Hawaii*, and to recommend that it be published as Botanical Bulletin No. 5 of the Division of Forestry.

In this paper Mr. Rock has brought together botanical information concerning the few endemic arborescent species of the family *Leguminosae* found in the Hawaiian Islands which should be of particular interest because of the fact that it includes descriptions of the well-known koa.

Very respectfully,

C. S. JUDD,
Superintendent of Forestry.

Approved:
Board of Commissioners of Agriculture and Forestry,
February 27, 1919.

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PREFACE

The Hawaiian Islands are very poor in arborescent *Leguminosae*; in fact, the whole family is very sparingly represented in comparison to families like *Rubiaceae, Rutaceae, Campanulaceae* tribe *Lobelioideae.*

Of truly endemic species other than arborescent ones the Islands possess only four, viz: *Canavalia galeata* Gaud. and a variety *pubescens, Vigna sandwicensis, Vigna oahuensis* and *Vicia Menziesii*; the last named has only been collected by early collectors such as Menzies, Macrae and Remy.

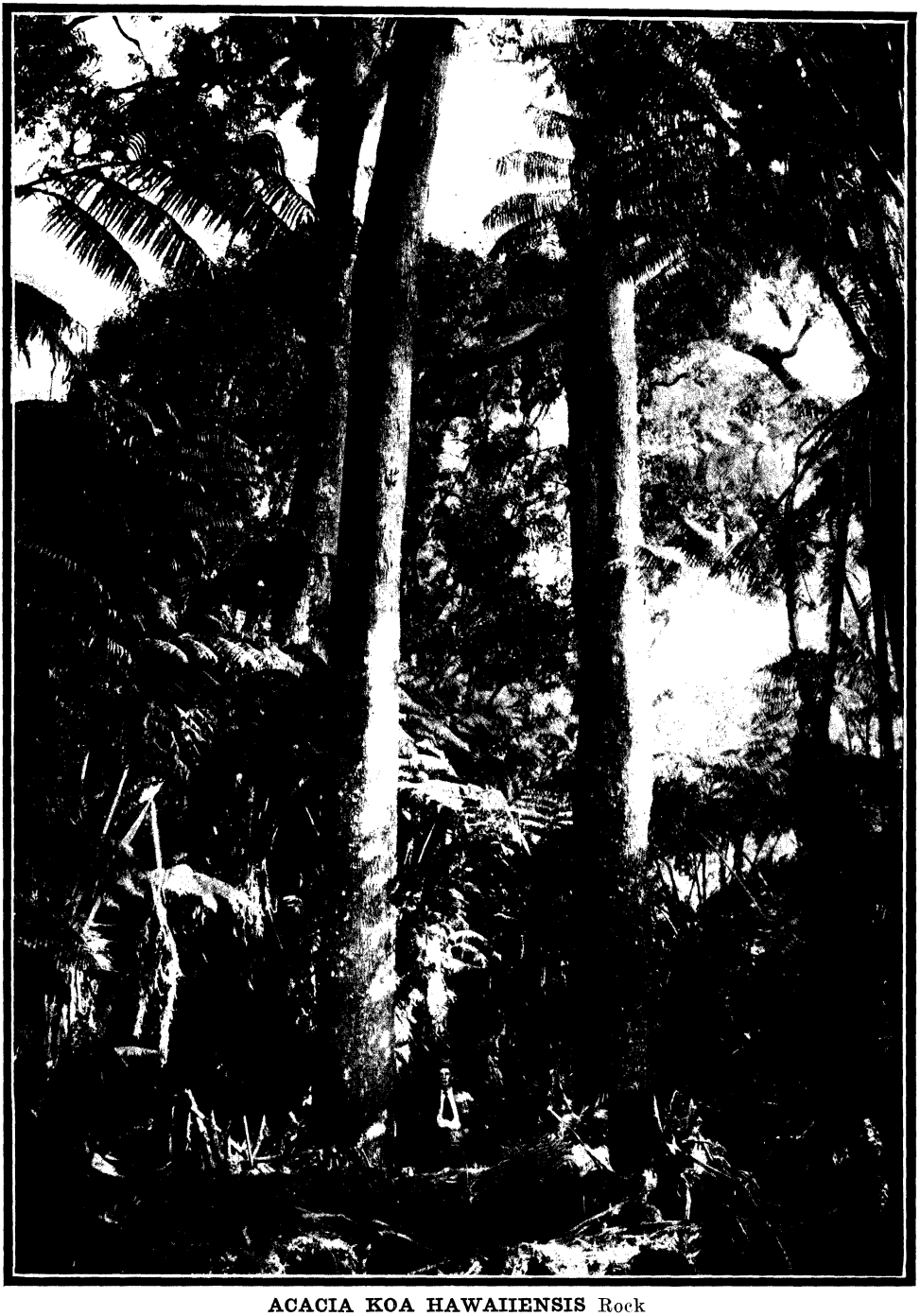
Of indigenous species found elsewhere we find twelve. A large number of species of *Leguminosae* have, however, been introduced and amount to about two hundred. Most of our introduced ornamental trees belong to this family.

THE GENUS *ACACIA*

Before discussing the three endemic Hawaiian species of *Acacia,* it may be worth while to consider the genus as a whole, at least its distribution. The name *Acacia* is of doubtful origin, but presumably has been taken from the word *akazo,* "I sharpen," in reference to the sharp spines with which many *Acacias* are fitted out, especially the African species, though a number of Asiatic species possess them also. Spines are, however, not characteristic of the Australian species, nor of any of those found elsewhere in the oceanic islands, as, for example, Hawaii, Fiji, Samoa, Tonga, and the New Hebridean group.

The genus *Acacia* is distributed over the warmer regions of the globe, but is particularly numerous in Africa and Australia. There have been described about 500 species or perhaps even more. The definite number cannot be given with any degree of certainty, as new ones are being continually discovered by botanists. The remarkable fact remains, however, that of the approximate five hundred species, more than three hundred are purely Australian. Of all these numerous species found in Australia, only a single one, *Acacia Farnesiana,* is not endemic; the rest are peculiar to that continent. Again, the largest number of the Australian *Acacias* belong to the *phyllodineous* series, while only about twenty of the three hundred species have bi-pinnate leaves. The *phyllodineous* tribe, that is species with *phyllodia* (dilated leafstalks) instead of true leaves, are almost all Australian with the exception of a very few species found in the Pacific islands such as Hawaii, New Caledonia, Mascarene and others. These cannot be identified with any of the Australian species, but, nevertheless, they do come close to some of the tropical Australian species, as, for example, *Acacia melanoxylon* to *Acacia Koa.*

Tropical Africa possesses in the neighborhood of about fifty species, all with true leaves, so that they do not concern us here. There is, however, no doubt that the *Bipinnatae* (or *Acacias* with true leaves) are the more primitive of the *Acacias.* Xerophytic regions are responsible for the reduction of true leaves to *phyl-*



ACACIA KOA HAWAIIENSIS Rock
Koa.

Showing straight growth of bole in wet or fern forest, near Volcano Kilauea, Hawaii; elevation 4000 feet.

lodia, as can be seen in certain bipinnately-leaved Australian species, where the leaflets of the pinnae have been reduced to a minimum, and where even the possibility exists to shed these leaflets in case of severe drought when their presence is either not necessary or dangerous to the plant. In no species of *Acacia* with typical bipinnate leaves has the occasional development of *phyllodia* been observed. The reverse has been of frequent occurrence. A number of *Phyllodineae* are known which revert back to bipinnate leaves, especially when they occur in situations with great humidity and where shade is prevalent. Bipinnate leaves will be found especially near the ground because of the proximity of humidity and shade condition, and also perhaps on account of their being primitive leaves. *Acacia Koa* in its young state, for example, especially when occurring in the rain forest, possesses bipinnate leaves only. Twigs with bipinnate leaves are occasionally found sprouting from the main trunks of large trees, especially after the winter rains.

The more primitive of the Australian *Acacias* are in all probability those with a globose (capitate) inflorescence, to which type the Hawaiian species belong. The *phyllodium* in *Acacia* is undoubtedly due to climatic conditions, and especially to light conditions. The drier and brighter the locality, the less foliage is usually developed and consequently the trees become open and shadeless. Wherever *Acacia Koa* grows in the rain forests of Oahu it forms dense globose crowns with a maximum amount of foliage, while *Acacia Koa hawaiiensis* in the upland of Hawaii produces large *phyllodes,* but the crowns are open and the foliage is scanty. Whether the described characteristics of *Acacia Koa hawaiiensis* are due to location or are inherent is difficult to state. The tendency to the development of broad phyllodes seems to be due to high altitude and consequent fog and mist. This has been illustrated in plants of *Acacia Koa hawaiiensis* grown from seed in San Francisco, California, whence Mr. W. M. Giffard brought the writer specimens of *phyllodia* of such width as have so far not been observed in any Hawaiian-grown plant. The narrow-leaved forms of the Oahu *Koa,* the true *Acacia Koa,* are due evidently to lower altitude and consequent absence of fog. The narrow *phyllode* is developed in greater number, resulting in a densely foliate crown.

The factors responsible for these types of *phyllodes* have, then, been light, warmth, humidity and soil. We must, however, look upon the *phyllodineous* character of *Acacia Koa,* not as evolved in Hawaii, but in its ancestor or ancestors on Australian soil. This character became modified by Hawaiian climatic conditions, which produced what we now recognize as *Acacia Koa,* its varieties, and *Acacia Koaia* and *Acacia Kauaiensis.*

Acacia melanoxylon R. Br. comes near *Acacia Koa hawaiiensis* especially in the vegetative organs if not reproductive organs, and fruit. The *phyllodes* of *A. melanoxylon* R. Br. or the Blackwood of Australia are much closer to the variety *hawaiiensis* of *Acacia Koa* than the true *Acacia Koa* of Oahu. Both have the broad, obtuse, almost straight phyllodes, the main difference being in the pod, which is narrow and more or less twisted in the blackwood and broad and straight in *Acacia Koa* and its varieties. The habits of the two species seem to be the same as the following extracts from Dr. J. H. Maiden's "The Forest Flora of New South Wales," and the illustrations of *Acacia Koa hawaiiensis* will corroborate. To quote:

"As far as southern New South Wales and Gippsland are concerned, the blackwood must be considered as a mountain species, though it occurs occasionally in the low coast land; but there it never attains any size. It varies a good deal in mode of growth, according to situation and geological formation. In the rich humus of the jungle of the mountain slopes, it attains a height of from 60 to 80 feet, and in Gippsland, along the boundary of New South Wales and Victoria, localities may be found where it attains a height of one hundred and twenty feet, and a diameter of nearly three feet. Their straight trunks may be seen without a limb, from sixty to eighty feet, the timber quite sound and possessing that beautiful dark color whence the species has derived its popular as well as its scientific name. When it grows on high mountains * * * amongst rocks and precipices it grows very gnarled and spreading, from twenty to forty feet high and from one to two feet in diameter, sending out thick, long, gnarled and crooked limbs quite close to the ground."

Any one who has seen *Acacia Koa hawaiiensis* on Hawaii in various stations such as humid rain forests and open lava flows, could hardly describe its habits otherwise than has been done by Dr. Maiden, in the article quoted on *Acacia melanoxylon.* The plates here introduced illustrate well these different habits.

THE GENUS *ACACIA* IN THE PACIFIC.

The number of *Acacias* in the Pacific islands is quite small, in comparison to the enormous number found on the continent of Australia. Those known are *Acacia spirorbis,* found in New Caledonia and the Isle of Pine, and *Acacia fulgens,* as well as *Acacia granulosa,* peculiar to New Caledonia.

Acacia laurifolia is one of the widest distributed species, being found in New Caledonia, Tahiti, Samoa, Tonga, and Viti Islands, as well as in the New Hebrides. *Acacia Richii* is peculiar to the Fiji Islands, where it occurs on Vanualevu and Naloa. In New Guinea a few species have been discovered, as *Acacia Simsii* in Dutch New Guinea, also *Acacia glaucescence.* Mr. Merrill described a *phyllodineous* species (*Acacia confusa*) from the Philippines, the only one of that type known from that archipelago. To us the most interesting of all *Acacias* is *Acacia heterophylla* of Mauritius and Bourbon of the Mascarene group in the Indian Ocean, thousands of miles distant from Hawaii, with which our *Acacia Koa* is almost identical. It certainly is most peculiar to find two plants practically not at all distinct from each other in two so extremely remote geographical stations as Mauritius, in the Indian Ocean, in the southern hemisphere, and Hawaii, in the north Pacific Ocean. New Zealand, in such proximity to the source of *Acacia,* at least to the *phyllodinous* species, has not a single indigenous *Acacia.*

The Hawaiian Islands possess three species of *phyllodineous Acacias* and two varieties of one species. The island of Kauai, by far the oldest of the group, possesses a species (*Acacia Kauaiensis* Hillebr.) which is peculiar to it. *Acacia Koa* is, however, not absent. The former species seems to be restricted to the western part of the island. The typical *Acacia Koa* occurs all over Oahu, in one locality on Molokai, and is more or less distributed on Maui. On the island of Hawaii it is represented by a variety, *hawaiiensis,* while on Lanai another variety, *lanaiensis,* represents it. *Acacia Koaia* Hillebr. is found on Molokai, Maui and Hawaii in dry situations.

Next to ohia lehua (*Metrosideros collina polymorpha*), *Acacia Koa* is one of the most common forest trees. It occupies the zone from 1000-4000 feet elevation, but in some instances

ascends to 7000 feet elevation, as, for example, var. *hawaiiensis* on Hawaii. The presence of *Acacias* in Hawaii must be attributed to birds, as the seeds of *Acacias* are not particularly adapted for dispersal by ocean currents. Yet the birds to which we could attribute this introduction, or rather which could be responsible for its presence in Hawaii, do not exist today, but were in all probability the now extinct *columbae* and their relatives. The thought of human agency must altogether be excluded when we examine the fauna to which *Acacia Koa* is host. The writer can only quote Dr. Perkins' able words:

"In judging the length of time that any particular plant or group of allied plants has existed in the islands, the botanist would be well advised to consider the fauna that is specially attached to these. When one considers that trees little modified from foreign species, e. g., *Acacia Koa* or *Sophora chrysophylla,* possess a great endemic fauna, not only species, but even genera of birds and insects, quite restricted to or dependent on them, and that some of these creatures are certainly themselves not less remarkable in their peculiarities than the most peculiar of the Composites or Lobelias, we may hesitate to attribute such plants to a later era than many other elements of the flora, which at first sight appear far more ancient."*

In following up Dr. Perkins' statement we find, however, that he had not so much *Acacia Koa* in mind as the *Compositae* and *Lobelioideae,* which, indeed, especially the latter, have peculiar birds dependent on them more or less for their existence. Dr. Perkins seems to class *Sophora chrysophylla* as an *Acacia.* To quote: "As with *Clytarlus,* the two native acacias, *Acacia Koa* and *Sophora chrysophylla,* are favorite foods of *Plagithmysus,* for six species are found on the former and three on the latter tree."‡

This would account for his remark that the Hawaiian *Acacias* have endemic genera peculiar to them. It is true that of fourteen species of the genus *Clytarlus,* all but one are peculiar to *Acacia Koa* and the single remaining one to *Sophora chrysophylla.*†

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* Fauna Hawaiiensis, Introduction, Vol. I, part VI, page 60.

‡ ibid, page 117.

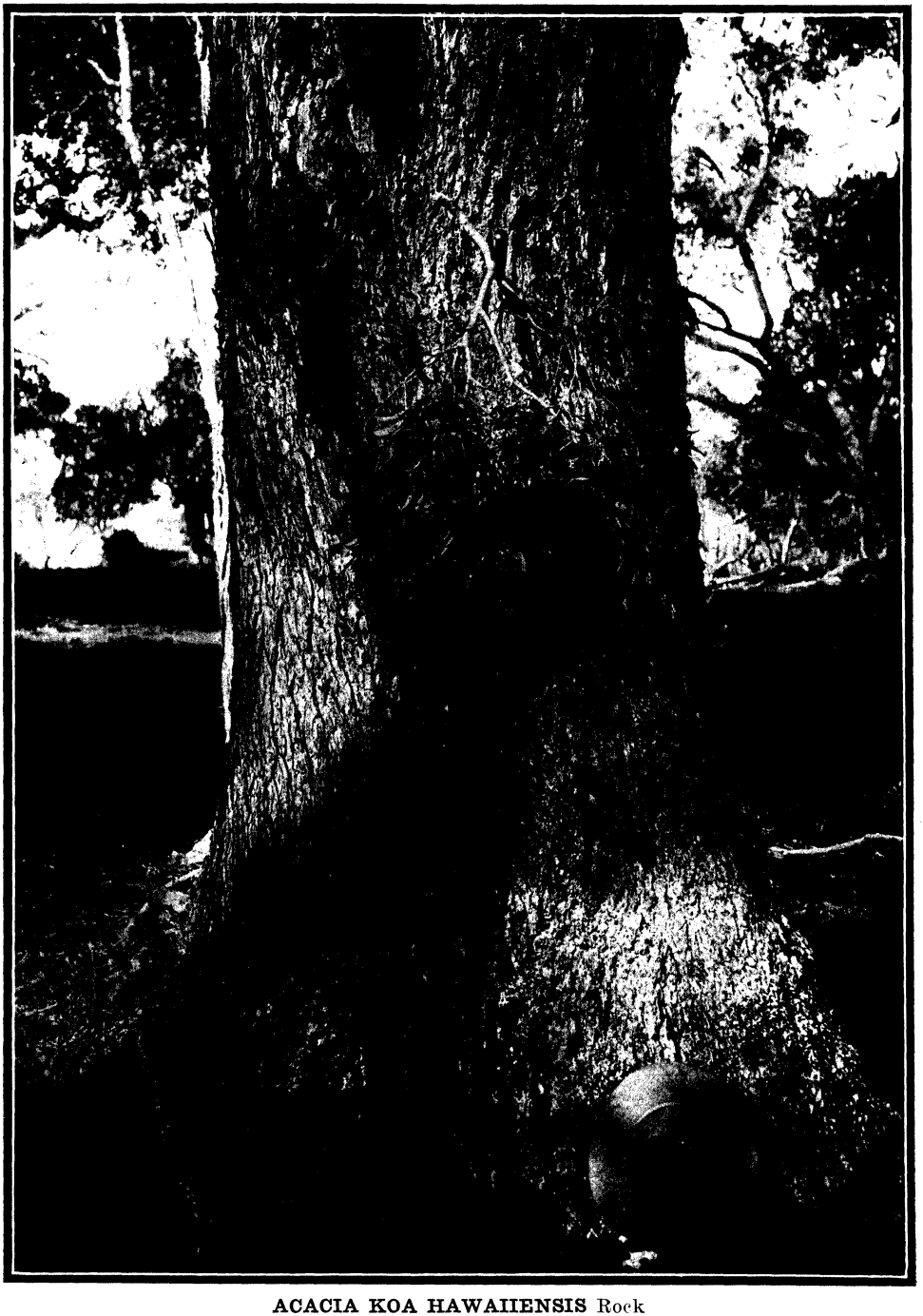
† For this information the writer is indebted to Mr. O. H. Swezey of the Hawaiian Sugar Planters' Experiment Station.

Perkins states that the remarkable bird *Pseudonestor* is continuously hunting for the larva of *Clytarlus* and those of *Plagithmysus,* and its stomach is often entirely filled with this food. All these facts tend to show that *Acacia Koa, A. Koaia* and *A. Kauaiensis* are old denizens and not recent arrivals, as must be assumed of *Metrosideros collina polymorpha,* the rival of *Acacia Koa.* Man, as the agent responsible for the presence of *Acacia* in Hawaii, must be absolutely excluded. For long before man in Hawaii, were the birds and native insects, and long before them the plants on which they are dependent for their subsistence.

The wood of the koa is a handsome brown, varying from very dark shades to a lustrous gold, often with a handsome grain, and is much prized for cabinet work. The large trunks supplied the Hawaiians with material for their dug-out canoes, and the bark was formerly used for tanning.

ACACIA KOA Gray
Koa.

About one-third natural size. Showing true leaves and phyllodia, flowers and fruits.



ACACIA KOA HAWAIIENSIS Rock
Koa.

Showing trunk, bark and flowering branch; near tree-molds, Kilauea, Hawaii; elevation 4000 feet.

Acacia Koa Asa Gray, Bot. U. S. Expl. Exped. 480. 1854.
Acacia heterophylla Hook. et Arn., Voy. Bot. Beech. 81. 1832.

Phyllodia falcate, coriaceous, 10-15 cm. long, varying from 6-8 mm. to 24 mm. or more in breadth, narrowed at the base, acute or obtuse at the tapering apex; the smooth surface is striate with many nerves, leaves on young plants bipinnate, each pinna consisting of 12-15 pairs of oblong emarginate, crowded leaflets; peduncles solitary or fascicled in the axils, about 12 mm. long, bearing a dense many-flowered head 8 mm. in diameter; calyx teeth very short; petals 5, oblong lanceolate, glabrous, more or less united, longer than the calyx, half the length of the stamens; legume broadly linear, straight or slightly falcate, 7.5-15 cm. long, 16-18 mm. broad, glabrous, flat, about 12 seeded, seeds flat, dark brown to black.

Acacia heterophylla Willd., with which *Acacia Koa* was first identified by Gaudichaud, who had seen both the Hawaiian plants and those of the island of Bourbon (Mauritius) growing in their respective native countries, differs from the Hawaiian *A. Koa* established by A. Gray very little, indeed, if at all. The writer has an authentic flowering specimen of *Acacia heterophylla* Willd. before him, from the Royal Gardens, Pamplemousses, Mauritius; the flowers which the writer examined of the last mentioned species differ very little from those of *Acacia Koa*; the sepals and petals in the Hawaiian plant are shortly dentiform, and like the petals united; the former are somewhat more deeply cut or in other words a little more lobed than in *A. heterophylla*. In the latter species the petals are slightly longer than in *Acacia Koa*. The *phyllodia* in *A. heterophylla* are much straighter, but are otherwise the same as in *A. Koa*; the leaflets are slightly shorter and broader. The difference, however, between *Acacia hetrophylla* and *Acacia Koa* is much less pronounced than that between *Acacia Koa* and *Acacia Koaia*. Asa Gray was correct in his statement: "*In distinguishing the two trees, peculiar to these most widely separated stations, perhaps I incur the charge of being influenced by geographical considerations rather than botanical characters.*"

Unfortunately the specimen in the College of Hawaii Herbarium of *A. heterophylla* has no pods, but from the description in Baker's Flora of Mauritius it can be judged that they do not differ much from those of the Hawaiian trees. On Hawaii the trees of *Acacia Koa* have certainly a different aspect from those

of Oahu, and broad *phyllode* specimens were named var. *latifolia* by Bentham; A. Gray states that it is only a state of the species. It is true that the *phyllodes* when young are of a different shape from the older ones, but in the Hawaii plants the mature *phyllodes* of any tree are much broader and ovate-oblong, and notwithstanding their width are shorter than or rarely as long as the Oahu specimens; they are, however, often more than twice as broad as those in the Oahu specimens. Whether the name *latifolia* was applied by Bentham to the young form of an Oahu specimen or to the typical Hawaii broad-leaved form cannot be determined now. The writer would suggest, then, for the Hawaii *koa* the varietal name *hawaiiensis*, and for Hillebrand's variety β, the name *lanaiensis*, since the variety has so far been found on Lanai only.

It is extremely interesting to find that in so widely separated regions as Mauritius, off the coast of Madagascar, in the southern hemisphere, and the Hawaiian Islands, in the middle of the North Pacific Ocean, there should occur two *Acacia* practically not at all differing botanically from each other. In the writer's opinion, A. Gray was not justified in establishing the Hawaiian *Acacia* as a separate species for mere geographical reasons. It may be stated that it is not taken for granted that *Acacia Koa* is derived from *Acacia heterophylla* or vice versa, but that they are an offspring from a common ancestor, the home of which was or is undoubtedly Australia, and that owing to similarity in climate and environment both have developed on common lines, notwithstanding the vast distance separating these geographical stations. The common ancestor may be looked for in relatives of *Acacia melanoxylon*, which has also connate sepals and petals, but varies mainly in the pod, which, however, comes exceedingly close to our *Acacia Koaia*.

Acacia Koa lanaiensis Rock
Acacia Koa β var. Hillebr. Flora Haw. Isl. 113. 1888.

A medium-sized tree, branching habit of the species, phyllodes 3.5-8 cm. long, 8-15 mm. wide, very little curved, almost straight, obtuse, mucronate, petiole about 4 mm., with the usual gland on the upper side; racemes very short, flowerhead and flowers as in the species; pod not seen.

Ex Museo botanico Berolinensi.

Acacia Koa
var. 3.
Kauai.

COLLEGE OF HAWAII HERBARIUM

ACACIA KOA LANAIENSIS Rock

LANAI: Hillebrand in Herbarium Berlin and part of type in the Herbarium of the College of Hawaii;—Puu Manu, elevation 1000 feet, also Waiakeaku, the last valley of the main ridge, flowering July 29, 1910, Rock no. 8028 in herbarium College of Hawaii.

Hillebrand's specimens of this variety are much more distinct than the writer's from Waiakeaku. While short obtuse *phyllodes* occur, long acuminate ones occur also. As a whole the plant from Waiakeaku is little distinct, but Hillebrand's specimens are undoubtedly worthy of varietal rank.

Acacia Koa hawaiiensis Rock

A lofty tree reaching 25-33 m., and a diameter 1.7-2 m.; branches gnarled wide spreading; glabrate when old, densely tomentose when young, with a yellowish green velvety tomentum; leaflets broadly sessile with an oblique base, narrower towards the apex, rounded, with minute mucro, glabrate on both sides, but rhachis tomentose; phyllodia broad obovate to ovate to linear-oblong, hairy when young on both surfaces, but soon glabrate, slightly curved, acute at both ends or obtuse at the apex and uncinate, many nerved (usually ten), 12.5-16 cm. long, 2.5-5 cm. wide, coriaceous, on petioles of about 5 mm., with a gland on the upper side at the base of phyllode; flowerheads single or two or three on a common peduncle of 1.5 mm., and the lateral ones, 3 mm.; heads densely flowered small; sepals one-third the length of the calyx, hirsute at the apex; stamens numerous; petals ovate, obtuse more than one-third the length of the corolla, pod about 11 cm. long, 2.5 cm. wide, flat, the suture straight or slightly wavy.

HAWAII: At the higher levels from 4000 to 6000 feet elevation;—Mt. Hualalai-Hinakapauula, fruiting June 10, 1919, Rock no. 3759;—Pulehua plains and forests, South Kona, flowering January 1912, Rock no. 12866;—Kau desert, elevation 3600 feet, July 15, 1915, Rock no. 12566—all in the College of Hawaii Herbarium.

This variety seems to be peculiar to the island of Hawaii, where it reaches very large dimensions. It can be distinguished mainly by its broad *phyllodes*, which are almost straight.

Acacia Kauaiensis Hillebr. Flora Haw. Isl. 113. 1888.

A large tree with many tortuous branches; phyllodia falciform, narrow-linear, 10-16 cm. long, about 12 mm. or less wide, with usually two or three prominent nerves, apex somewhat obtuse, mucronate-uncinate, with

ACACIA KOA HAWAIIENSIS Rock

ACACIA KAUAIENSIS Hillebr.

a pitted gland on the somewhat thickened petiole; inflorescence paniculate, terminal, foliose, or rather a paniculate raceme with phyllodia in the upper axils and below which are situated the peduncles of about 1 cm. in length, each bearing several single-headed pedicels 4-6 mm. in length, tomentose with a rusty tomentum; bracts minute; sepals 5-6, free to near the base, spathulate-obtuse, glandular pubescent as are the petals, the latter oblonceolate, one-half longer than the sepals, ovary puberulous; pod straight thick, coriaceous, 15 cm. long, 2 cm. wide, about 15 seeded, seeds as in **A. Koa.**

KAUAI: Halemanu, Knudsen no. 55; — Halemanu, fruiting February 14-26, 1909, Rock no. 2154 in College of Hawaii Herbarium;—Kaholuamano, outskirts of the forest, flowering October 1911, Rock no. 2755-b (type);—same locality, flowering October 1916, Rock no. 12868 in the herbarium of College of Hawaii.

The apparently typical form is no. 2755 from Kaholuamano and no. 2154 from Halemanu, where V. Knudsen collected his specimens. The free sepals and petals, and the racemose-paniculate inflorescence, distinguish this variety at once from the species; otherwise it has the same habit as *A. Koa.* This rather interesting tree, which Hillebrand established as a species, distinct from *A. Koa,* has hitherto been overlooked owing to its great resemblance to *Acacia Koa.* It inhabits the dry open slopes on the leeward side of Kauai on the edge of the canyons, especially on the Halemanu side along the Waimea canyon to Milolii. At the Kaholuamano side, where there seems to be a little more rainfall, the *phyllodia* are larger and the inflorescence is not exactly paniculate, though the sepals and petals are free. The tree does not reach such dimensions as the variety *hawaiiensis* of *Acacia Koa,* the trunk being usually short and the branches a good deal twisted and sometimes reclining nearly on the ground. The *phyllodia* are long, sickle-shaped and narrow, the upper ones being uncinate. Similar to *Acacia Koa hawaiiensis,* when growing in damp or wet mixed forests in company with other trees, it develops a tall straight bole some forty feet without branches, after which the crown commences. Beyond the Kopiwai forest it grows in company with *Xanthoxylum dipetalum Hillebrandii* Rock (*X. dipetalum* var. γ Hillebr.), *Alphitonia excelsa, Antidesma platyphyllum, Pelea Kauaiensis, Santalum pyrularium,* and others.

Acacia Koaia Hillebr. Flora Haw. Isl. 113. 1888.

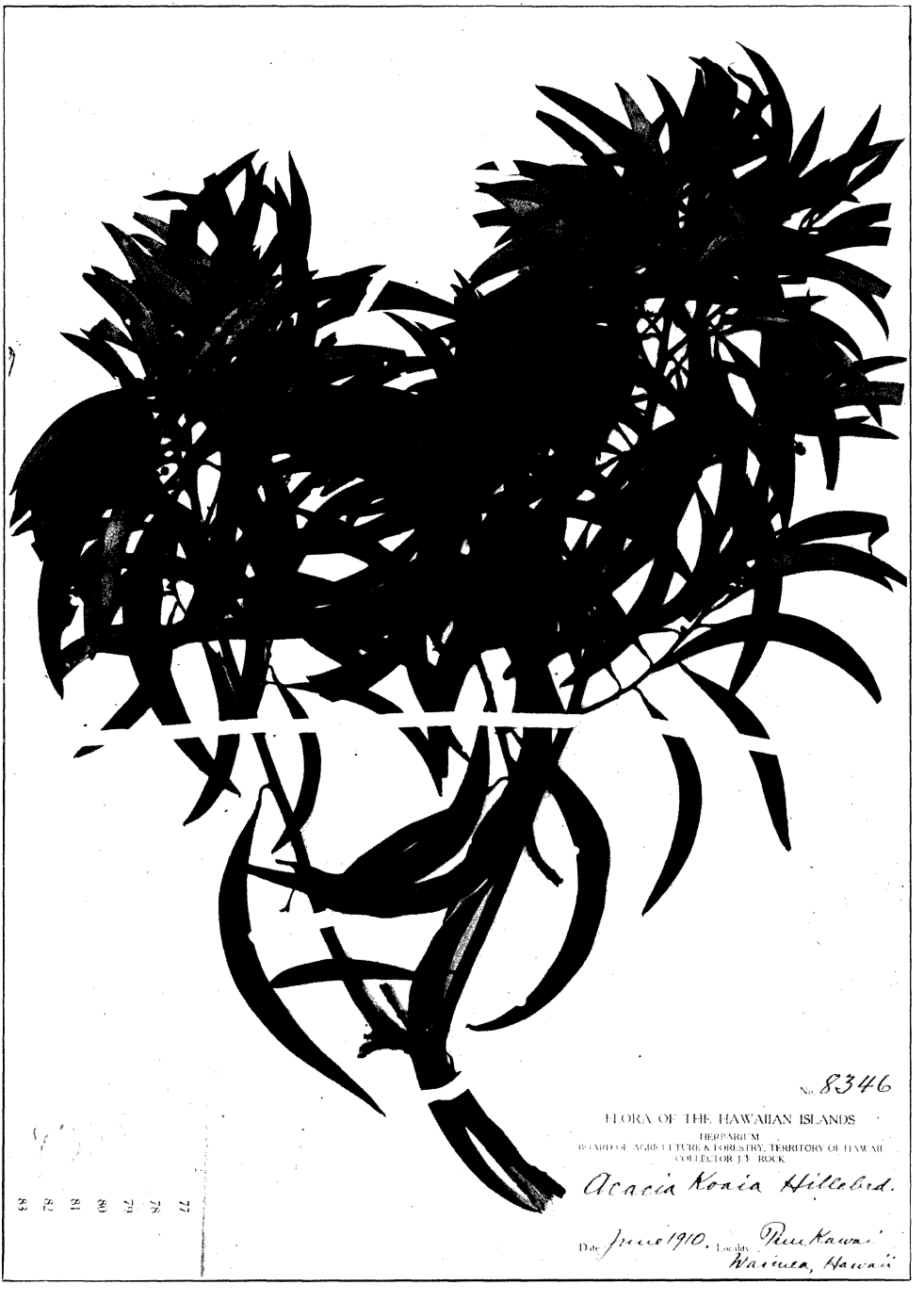
A small gnarled tree, wood hard, close grained; branches terete, true leaves not seen; phyllodia coriaceous, falcate, linear, narrow, acute at the apex, acuminate at the base, with three prominent nerves, 6-12 cm. long, 8-10 mm. broad, the apex with a recurved mucro; petiole about 5 mm., with a thickened gland on the convex side of the petiole or rather base of the phyllode; racemes axillary with not more than three heads, generally reduced to a single one; flowers as in **Acacia Koa**; pod very narrow, 8-10 mm. in width, 10-15 cm. long, somewhat curved, not of even width, but with slight constriction between the seeds; seeds oblong, the long diameter (6 mm.) in the direction of the valves, flattened, with a funis of about the same length.

MOLOKAI: Kalae, Hillebrand in Herbarium Berlin and in the College of Hawaii Herbarium;—ridge above Kaunakakai and Kauluwai, March 1910, Rock in College of Hawaii Herbarium.

MAUI: E. Maui, Kula? Hillebrand.

HAWAII: Puukawai, Kawaihaeiuka, elevation 2000 feet, near Waimea, flowering and fruiting June 1910, Rock no. 8346 in the College of Hawaii Herbarium;—observed back of Puuanahulu, near Puuwaawaa boundary, on rough ancient aa lava flows.

Acacia Koaia Hillebr. differs from *Acacia Koa* A. Gray mainly in the pods, which are very narrow and somewhat curved. Also in the *phyllodes,* which are narrow linear and less curved. *Acacia Koaia* or *Koaie,* as the natives call this species, and which name was adopted by Hillebrand as the specific name, has a rather restricted distribution. It seems to be the older of the two species occurring in these islands. So far as known, it is absent from Kauai, Oahu and Lanai, also Niihau and Kahoolawe. On the three remaining islands it occurs only sparingly. On Molokai the writer collected it at Mapulo-u immediately below Kamoku on the dry exposed ridges leading towards the dry stony slopes of the Kaunakakai-Kauluwai district. It is a small bushy tree on the crest and protected declivities of a ridge, where it grows in company with *Myoporum sandwicense, Nothocestrum latifolium, Sideroxylon molokaiense* Rock (*S. spathulatum molokaiense*) and a species of *Lipochaeta* (*Nehe*). On the same island it was collected by Hillebrand at Kalae. On Maui it was collected by Hillebrand only on the lee slopes of Haleakala at



ACACIA KOAIA Hillebr.

Kula. The Kula region is now almost barren and waste, save for a few *Dracaena aurea* (*Halapepe*) trees which were in existence a few years ago.

Until 1909 *Koaia* had not been recorded from the island of Hawaii. The writer discovered it on the upper slopes of Kawaihae in the neighborhood of the extinct crater Puukawai along the road leading to Waimea. Quite a number of trees were then in existence. It was also quite common on the Puuanahulu side of Puuwaawaa, where it grew in company with tall *Osteomeles anthyllidifolia* (*Ulei*) bushes. As it occurs in the very arid rocky regions, it is doomed to extinction, for such regions on Hawaii have been given over to cattle and sheep grazing; young plants which would perhaps germinate after southerly rains are eagerly devoured by both cattle and sheep. Owing to the causes just mentioned, *Koaia* has already disappeared from Maui. On Molokai a similar fate awaits it if it has not already been exterminated by roaming horses, cattle and sheep.

Acacia Koaia is easily distinguished from *koa* in the more rigid phyllodes and narrow, curved pods. It can be recognized even from a distance by its shape; its stature is much smaller than that of *Acacia Koa*, reaching rarely more than 25 feet. The trunk is usually gnarled and twisted. On Hawaii it associates with *Nothocestrum breviflorum*, *Sophora chrysophylla*, *Myoporum sandwicense*, *Nototrichium sandwicense* and *Dracaena aurea*. It is strictly a subxerophytic plant, inhabiting only the more arid lava regions or volcanic tufa soils such as predominate on Puukawai, Hawaii. It is never found on the newer lava flows as is, for example, the *Acacia Koa*, but in older geological regions. The Waimea side of Hawaii known as the Kohala mountains are extremely old and were evidently once a separate island from Hawaii. *Koaia* does not occur on the younger portion of Hawaii save near Puuanahulu, a place not distant and adjoining Kawaihaeiuka. It is probable that ages back it occurred only on the Kohala range and that it spread afterwards towards the plains and north Kona. Unfortunately, we know very little of the plant-covering which must have existed on the vast plains between Waimea and Mauna Kea. Evidences are still visible of former forests, but so meager are they that it is impossible to draw conclusions. Mamani (*Sophora chryso-*

phylla) forests must have extended considerably over this plain, as the upper part of that region would indicate by the scattered trees around Punohu and Makahalau. Kawaihae-uka, judging from Hillebrand's reports, must have supported a similar vegetation, as does Puuwaawaa today, and *Acacia Koaia* may have been quite numerous there. Another factor influencing the (restricted) distribution of *Koaia* is undoubtedly the adaptability of the species to lower levels only, while *Koa* has been observed up to 7000 feet. *Koaia* does never ascend higher than 2500 feet, consequently the arid regions at such altitudes suitable to its existence are rather limited, while *Koa*, with its wonderful adaptability, which can be compared with that of *Metrosideros*, has a very wide distribution in these Islands and can be found from practically sea level to 7000 feet, in most varied stations, as to soils, and lava flows.

MEZONEURUM Desf.

The genus *Mezoneurum* is represented in the Hawaiian Islands by a single arborescent species originally discovered by H. Mann on the island of Kauai, hence the specific name *Kauaiense*. The species had undoubtedly a much wider distribution in this archipelago. It is found on Maui and Oahu (according to Hillebrand) and also on the island of Hawaii in the dry forests of North Kona, where it was found by both Guppy and the writer. That the tree was much more common in the days of the old chiefs than now can be judged by the great many tapa beaters (made of the exceedingly hard wood of this species) which can be found in the Bishop Museum and private collections all over the Islands. Undoubtedly, the usefulness of the wood of this tree, which was very highly prized by the natives, not only for tapa beaters, but also for the *laau melomelo*, a club-shaped piece of *Mezoneurum* wood employed in a peculiar method of fishing, is responsible for the scarcity of this tree nowadays, and the writer ventures to say that there are hardly two dozen trees of this species in existence.

The presence of this species in the Hawaiian Islands is certainly a riddle for the student of plant dispersal, especially as *Mezoneurum Kauaiense* belongs to a genus of which no littoral

MEZONEURUM KAUAIENSE (Mann) Hillebr.
Uhiuhi.

Flowering and fruiting specimen. About one-third natural size.

species is so far known, from which the Hawaiian one could have been derived. The seeds of this species are quite large, about an inch long, little more than half an inch wide, and are enclosed in a very papery thin pinkish-white pod winged at the upper margin. The seeds, like those of *Erythrina monosperma,* are not buoyant, and as the genus *Mezoneurum* possesses no littoral species from which it could have been derived, we must look for other agents than ocean currents as responsible for its presence in Hawaii. The Hawaiian species is endemic, which is not the case with *Erythrina monosperma,* as the latter is also found in Tahiti and New Caledonia.

Since we cannot look upon its presence here in these Islands as due to ocean currents, we can only take bird agency into consideration, and if a bird was capable of carrying such a large seed as that of *Mezoneurum Kauaiense* across a wide expanse of ocean, then surely it was also capable of carrying the much smaller seeds of wiliwili, *Erythrina monosperma,* and thus the presence of *Mezoneurum* in Hawaii strengthens and confirms, rather than contradicts, the arguments in favor of bird agency in the case of *E. monosperma,* as set forth in the discussion of that species.

That *M. Kauaiense* belongs to an ancient floral element in these Islands rather than to a later one, there remains no doubt.

The distribution of the genus proper would also indicate it to be a rather ancient one; and although the genus numbers only about fifteen species, so far as is known today, it enjoys certainly a very wide distribution. The majority of its species are Indo-Malayan, occurring in Java, Sumatra, India, Malay, Burma, the Philippines and even China, while others are found in tropical Africa, Madagascar, Australia, and one in Hawaii. None of the other Pacific islands possesses a species belonging to this genus, and the remarkable fact remains that the species found outside of Hawaii are all strong climbers, often thorny, or scandent shrubs, while the Hawaiian species is apparently the only tree in the genus. In Hawaii the tree reaches a height of over thirty feet, with a diameter of trunk of over one foot. The relationship to other *Mezoneura* is very vague, and at present no particular country of origin could be suggested.

The relationship of *Mezoneurum* to *Caesalpinia* is very close,

and as the latter genus possesses a number of littoral species, it may be that it originated from that genus; this is Guppy's theory. The writer is inclined to believe that *Mezoneurum* is older than *Caesalpinia* and that it is perhaps more probable that the littoral species have been derived from the inland species, and he would suggest that *Caesalpinia* is perhaps a satellite of *Mezoneurum*. The genus *Canavalia* in Hawaii does not help to elucidate the problem. Though of very wide distribution, it possesses both littoral and inland species. In Hawaii it is represented by an inland species, *C. galeata,* which species is represented by a variety *pubescens* on the southernmost island of this group, Hawaii. Until recently *C. galeata* was considered the only representative of this genus in Hawaii, but in 1910 the writer discovered *C. sericea,* a South Sea Island littoral species, on the eastern shore of the small island Lanai.

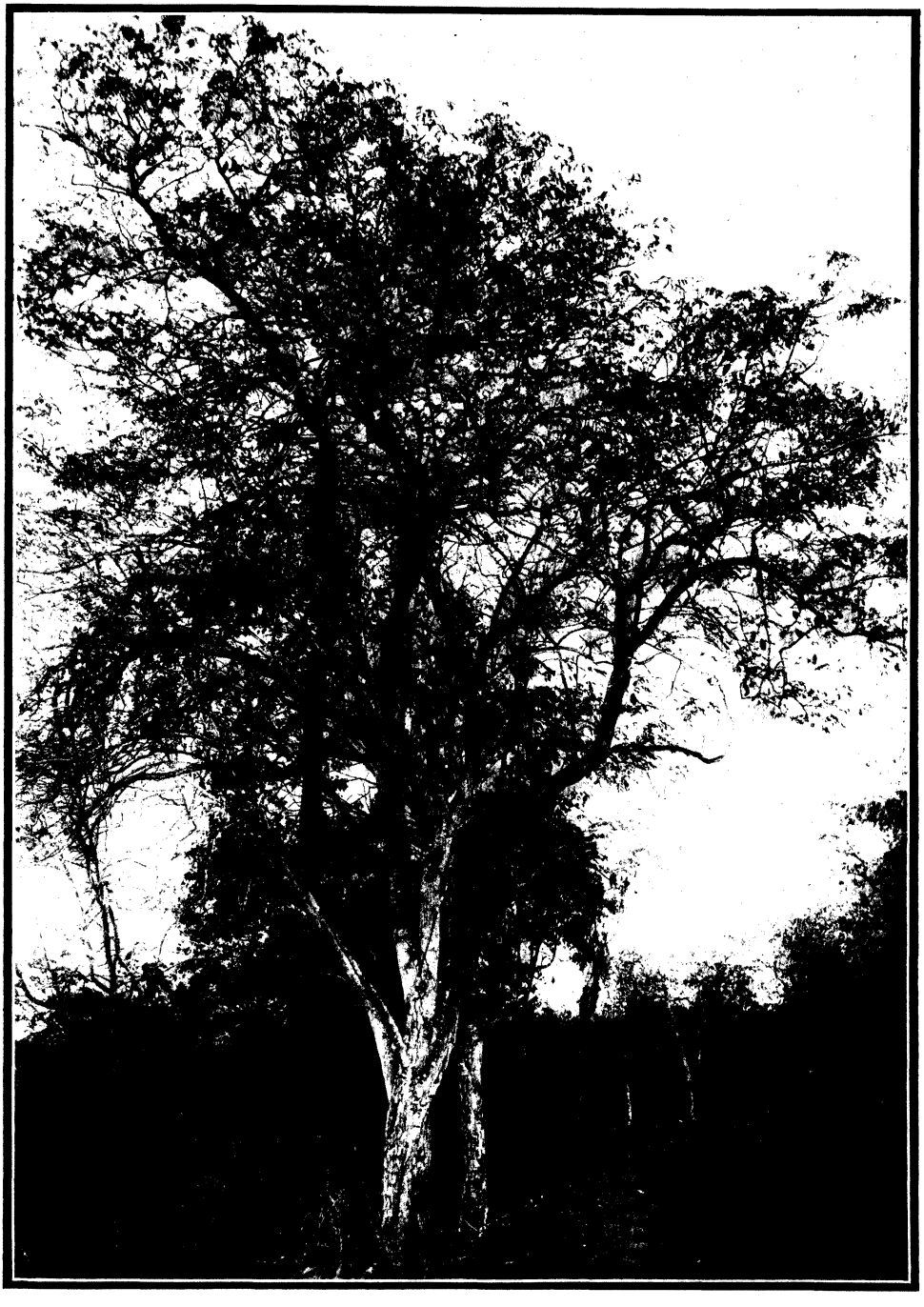
It is interesting to note that *C. sericea,* although a shore species, had the habit of *C. galeata.* It grew, not in the sand, but among lava rocks near old *Cordia subcordata* trees which the plant had climbed and festooned in a similar manner as *C. galeata* festoons trees at 2000 feet elevation.

The seeds of *C. galeata* are slightly smaller than those of *Mezoneurum Kauaiense,* and are also non-buoyant. *Mezoneurum* is by far the older genus as compared with *Canavalia* and *Caesalpinia,* from the mere fact that *Mezoneurum* possesses only inland species, while the other genera possess both littoral and inland species. Had the inland species of *Mezoneurum* been derived from one or various littoral species, we would probably have found somewhere a littoral species related to some or one of the inland species. The negative findings would indicate *Mezoneurum* to be older than the genera with both littoral and inland species to which it is apparently related. The arborescent character of the Hawaiian species adds still more to the difficulty of solving its origin and relationship.

Mezoneurum seems to be more a continental genus, for Hawaii is apparently the only oceanic island on which a representative is found. Java, Sumatra, the Philippines and Madagascar are always considered islands of continental origin.

MEZONEURUM KAUAIENSE (Mann) Hillebr.
Uhiuhi.

Showing trunk with bark and flowering and fruiting branch pinned to it. Trunk about 1 foot in diameter. On lava fields of Puuwaawaa, North Kona, Hawaii; elevation 2000 feet.



MEZONEURUM KAUAIENSE (Mann) Hillebr.
Uhiuhi tree.
Along the government road in North Kona, Hawaii; elevation 2000 feet.

Mezoneurum Kauaiense (Mann) Hillebr. Fl. Haw. Isl. 110. 1888.

Caesalpinia Kauaiensis Mann in Proc. Am. Ac. VII:164. 1866.

A shrub ? or tree 10 m. in height with a diameter of trunk of 3 dm. or more; bark thick, rough dark gray, checked into rectangular or long oblong plates; branches loose, spreading, unarmed, young shoots covered with a rust to cinnamon-brown pubescence; leaves pari-pinnate, with 1-5 pairs of pinnae, each pinna with 4-8 pairs of leaflets, pinnae 4-8 cm. long; the common rhachis up to 12 cm.; leaflets oblong, somewhat uneven-sided at the base, emarginate at the apex up to 4 cm. long, 16 mm. wide, membranous to chartaceous, pale green with rusty-brown pubescent mid-rib and petiolule, the latter 2-2.5 mm.; stipules and stipellae none or small wart-like; racemes terminal hoary to rusty-brown pubescent, 12-18 cm. long with flower, 22 cm. with fruit, densely floriferous from the base; pedicels 2.5-4 cm. long, jointed in the upper fourth, bracts acute, ciliate, 4 mm., caducous; bracteoles wanting; calyx glabrous, pinkish or rose red, the short tube 4 mm., the lowest lobe concave 12-14 mm., the others oblong, obtuse about 8 mm. long, 5 mm. wide; petals pinkish purple to rose red, not or slightly stipitate, shorter than the calycine lobes, the uppermost one obcordate, folded 6-8 mm. in diameter, of deeper color (blood red especially towards the apex), the lateral ones subor-bicular, the two lowest obovate, 10-12 mm. long; stamens exserted, declinate, filaments broad and flat below with reddish brown hair; anthers 2 mm., of carmine color; ovary glabrous, sessile 3-5-ovuled; style glab-rous incurved; stigma small; pod broad obovate-oblong 10 cm. long, 6 cm. wide, including the 7 mm. wide dorsal wing, ending in an uncinate point, flat, thin, indehiscent pale pinkish to gray when old; seeds 2-4, trans-verse, pale brown, ovate flat 18-20 mm. long, 14-16 mm. wide, with a punctiform hilum at the base.

KAUAI: Hillebrand in herbarium Berlin and herbarium College of Hawaii;—Puukapele, Waimea canyon, flowering March 1909, Rock no. 2435 in herbarium College of Hawaii.

OAHU: Waianae Mts. and Wailupe, Hillebrand.

MAUI: East Maui, Ulupalakua, and West Maui, dry fore hills, Hillebrand.

HAWAII: Between Huehue and Puuwaawaa, North Kona (district of Owe), elevation 2000 feet, flowering and fruiting June 14, 1909, Rock no. 3904 in herbarium College of Hawaii;—same locality, fruiting August 1915, Rock no. 12591 in herbarium College of Hawaii.

In the Hawaii specimens the dorsal wing does not end in an uncinate point as in the Kauai specimens; at least the point is very obscure. Hillebrand records this species as a shrub, but on Hawaii it is always a tree up to thirty feet in height. The writer

has collected it only on Kauai and Hawaii. In the former island it is very rare and perhaps extinct now; from Maui, Ulupalakua, it has disappeared, as the locality recorded by Hillebrand has been entirely denuded of its native vegetation.

According to natives, it exists along Kaupo below the southern outlet of Haleakala crater, Maui, where the natives know it by the name *Kea.*

The wood of this species is exceedingly hard, close-grained and very durable. It is of almost black color, with a very narrow (one-quarter of an inch thick) sapwood of a light color. The natives made their spears of this wood, also a fishing implement known as *laau melomelo* or *laau makaalei.* The native name of the tree is *Uhiuhi.*

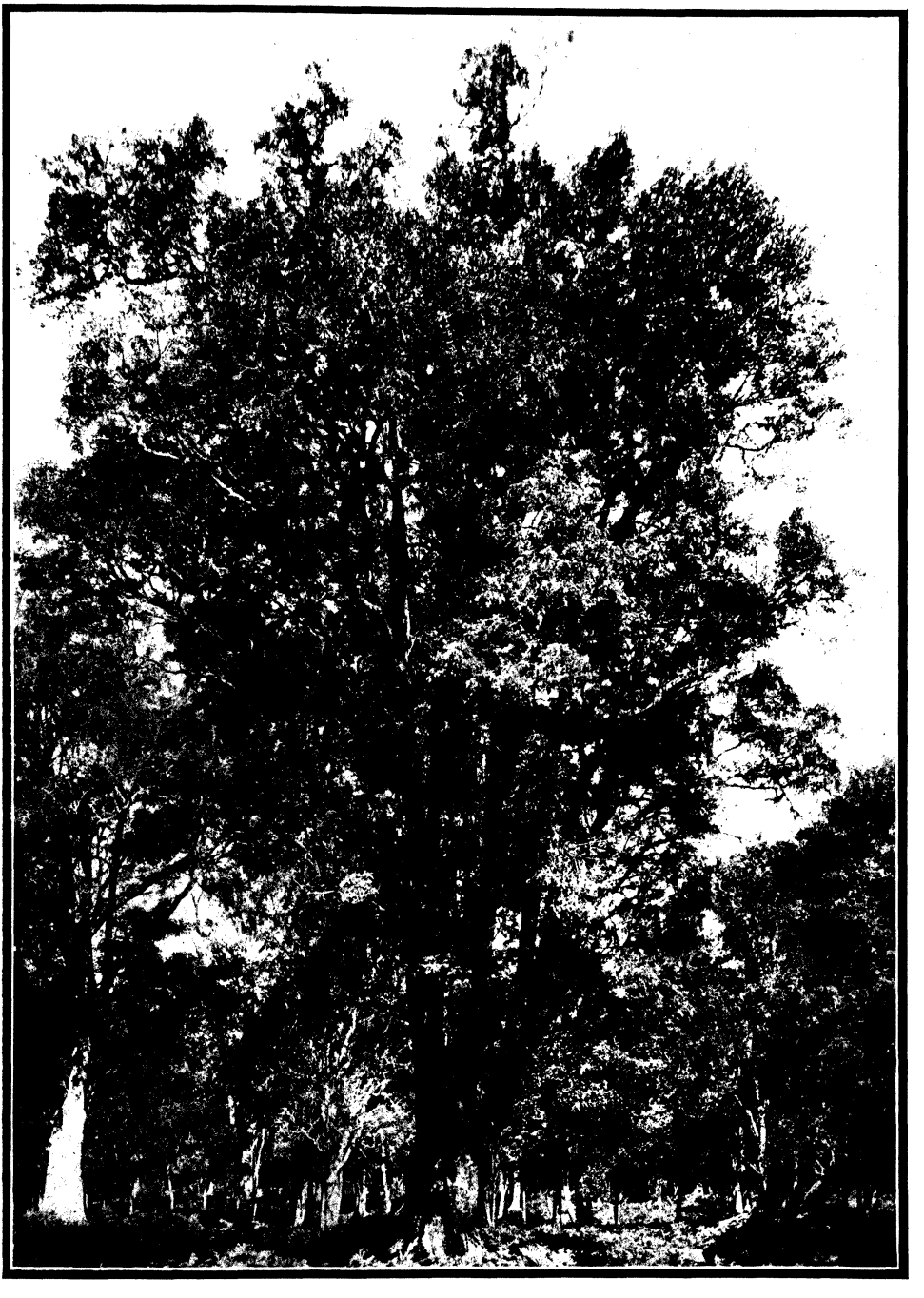
SOPHORA L.

Origin of *Sophora chrysophylla.*

That the *Mamani,* as the natives call *Sophora chrysophylla,* is an old denizen of these Islands there is little doubt. It may be of the same age as *Acacia Koa,* or may even antedate the latter. The *Mamani* belongs to the subgenus *Edwardsia,* in which we find *Sophora tetraptera, S. macrocarpa, S. microphylla, S. denudata, S. mollis* and *S. interrupta.* They are distinguished by their winged pods. In looking at the species which form this subgenus, we find that *Sophora tetraptera* occurs not only in New Zealand, but also on the Island of Juan Fernandez, Lord Howe's Island, Chatham Island, Easter Island and in Chile. *S. mollis* and *S. interrupta* occur in India, *S. macrocarpa, S. microphylla* and related species in Chili and Peru, while *S. denudata* is peculiar to Bourbon. That the Hawaiian Sophora is very closely related to *Sophora tetraptera* there is no doubt. It also occurs from sea level to 2500 feet elevation. At the lower altitudes it is a shrub, while at higher altitudes it is prostrate, while at favorable locations it becomes a tree 30-50 feet in height. *Sophora tetraptera,* the *Kowhai* of the Maoris, is very variable; a number of varieties have been described. A similar variation we meet in the Hawaiian *Mamani.* On comparing the New Zealand name "*Kowhai*" with "*Mamani*" from Hawaii we find no resemblance,

PLATE XII.

SOPHORA CHRYSOPHYLLA Seem.
Mamani.
Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet.



SOPHORA CHRYSOPHYLLA Seem.
Mamani.
Growing in Kipuka Puaulu, near Volcano Kilauea, Hawaii; elevation 4000 feet. Tree 35 feet high.

but on investigation we find the Hawaiian name *Ohai* used for *Sesbania tomentosa,* also a papilionaceous legume, with large red flowers, which resemble those of the *Mamani.*

The wide distribution of *Sophora tetraptera* and its occurrence in Chili would point to an American origin, rather than that it originated in New Zealand and was thence distributed to the other islands and the mainland of South America. The Hawaiian *Mamani* is in all probability of American origin and perhaps only an offspring of the ancestor of *Sophora tetraptera.* That the *Mamani* is an ancient inhabitant of Hawaii is proven by the fauna inhabiting it; we find two species of *Plagitmysus,* an endemic genus, peculiar to the *Mamani,* as well as species of *Clytarlus.* The peculiar endemic bird *Pseudonestor* feeds in turn on the larvae of these beetles, which it extracts from the wood of both the *Koa* and *Mamani.* From these facts we can see that both the *Koa* and *Mamani* must be old inhabitants and were perhaps contemporaneous in their arrival with the early *Compositae.*

Sophora chryosphylla (Salisb.) Seem. Flora Vitiensis 66. 1865. *Edwardsia chrysophylla* Salisb. in Transact. Linn. Soc. IX:302, t. 26, f. 1. 1808.

Young shoots silky pubescent; leaves 15.5 to 15 cm. long, with 6 to 10 pairs of leaflets; leaflets obovate oblong, 20 to 36 mm. x 8 to 12 mm., obtuse, often retuse, with a cinerous silvery or tawny pubescence (when growing at high altitudes) or glabrous (at low elevation); racemes terminal and lateral, 12 to 25 mm. long, tomentose; calyx about 6 to 10 mm., cup-shaped lobes broad and obtuse; petals 25 mm. long, yellow, the broad vexilum recurved, the suberect alae and carina nearly as long; stamens as long as the carina; ovary tomentose; pod 10 to 15 cm. long, 8 mm. wide, often deeply constricted between the seeds, four-winged; indehiscent; seeds 4 to 8, oval, somewhat compressed, yellow, 8 mm. long.

OAHU: Waianae Mts., Keaau, elevation 950 feet, flowering and fruiting January 23, 1919, Charles S. Judd, specimens in College of Hawaii Herbarium.

KAUAI: Knudsen in Herbarium Hillebrand (Herbarium Berlin).

MAUI: Slopes of Haleakala, flowering April 26, 1909, R. S. Hosmer no. 2624 in the herbarium of the College of Hawaii;—Haleakala upper slopes, flowering May 1911, Rock in herbarium College of Hawaii.

HAWAII: Hualalai upper slopes, elevation 7000 feet, flowering June 9, 1909, Rock no. 3502 in the herbarium of the College of Hawaii;—Mauna Kea, Parker Ranch, 1909, Rock in herbarium College of Hawaii;—Kaluamakani crater, Mauna Kea, flowering July 1, 1909, Rock no. 3225 in herbarium College of Hawaii;—Waikii, Mauna Kea, flowering June 1910, Rock no. 8418 in herbarium College of Hawaii.

Sophora chrysophylla has also been collected by Menzies, Meyen, the U. S. Exploring Expedition, Remy, Mann and Brigham, Hillebrand, Forbes, Faurie, Curran, and others.

The *Mamani*, which may be found on all the islands with the exception of Molokai, grows from almost sea level up to nearly 10,000 feet elevation. It inhabits the high mountains of Hawaii, Mauna Kea, Mauna Loa and Hualalai up to 10,000 feet, where it forms the upper forest zone together with shrubby Composites, such as *Raillardia arborea* and *R. struthioloides* and other plants peculiar to these regions. On Kauai and Oahu it never grows to a tree, while on the slopes of Mauna Loa, on Hawaii, near the volcano of Kilauea, it reaches its best development. Trees of 40 feet in height are not uncommon at an elevation of 4000 feet. Below and above the snow-line it is covered with silvery-gray hair, which protects it from the severe cold which it experiences, not only during the winter, but also in the summer months. The writer experienced a temperature of 19° Fahr. during a night spent on Mauna Kea in the month of July.

The specimens from Haleakala have glossy leaves with a grey pubescence; the latter disappears from the upper side entirely, but remains on the lower surface. The Mauna Kea specimens have narrow leaves, as have those from Haleakala, Maui, while the trees from the higher slopes of Hualalai, Hawaii, have broad ovate leaves; the latter specimens have also the largest flowers.

The wood of the *Mamani* is exceedingly hard and very durable in the ground. It is therefore mainly used for fence posts by the cattle ranchers on the large estates on Hawaii. On Haleakala, Maui, the trees are of medium size, though reaching a similar development at Auahi as that found near the volcano of Kilauea at Puaulu on Hawaii. On the upper slopes of Haleakala they

are shrubby. The wild cattle and horses, which are very numerous on the upper slopes of Mauna Kea, live almost exclusively on the young leaf shoots of the *Mamani* during the dry season, when there is no grass available. But, thanks to the hardiness of the trees, which are exceedingly deep-rooted, they are able to withstand the ravages of the descendants of Vancouver's cattle.

The *Mamani* is peculiar to the Hawaiian Islands, while *S. tomentosa* is found in the South Sea Islands, where it grows on the beach; in Viti or Fiji it is known by the name *Kau ni alewa*, or women's tree.

The *Mamani* is very closely related to *Sophora tetraptera* of New Zealand, Juan Fernandez, Lord Howe's Island, Chatham Island, Easter Island, and Chili.

Sophora chrysophylla glabrata Rock

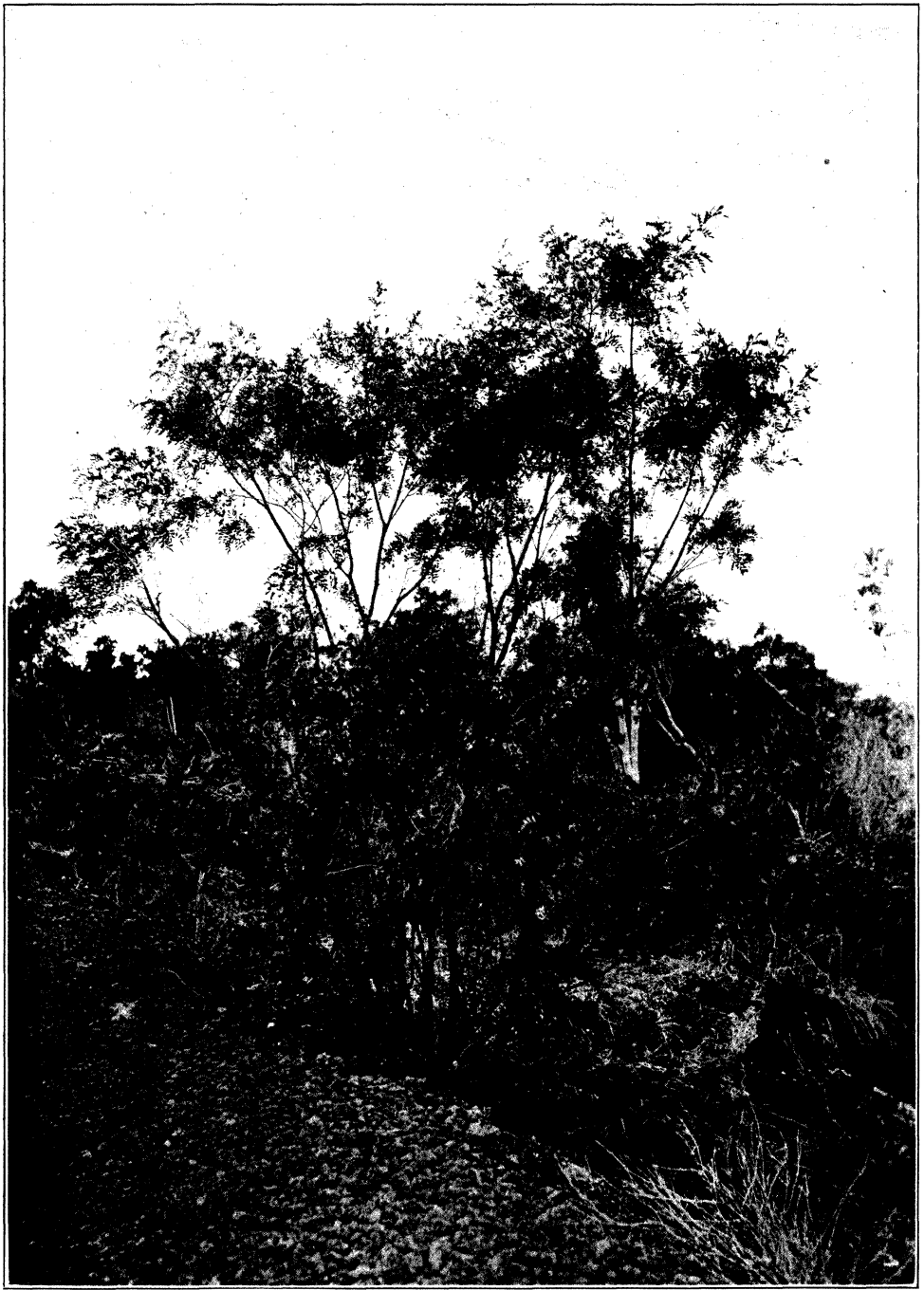
Edwardsia chrysophylla var. *β glabrata* A. Gray U. S. Explor. Exped. 459. 1854.

A shrub, 4-5 m. high, never a single trunk, more or less glabrate throughout, the leaflets are long, linear-oblong, 2.5 cm. long, 6-8 mm. wide, glabrate or slightly pubescent on both sides, flowers smaller of a paler yellow, calyx thin, brownish pubescent; the pods (in the Lanai specimens) with very narrow wings, the latter only 1 mm.

LANAI: On the plateau leeward side, near Koele, back of Gibson Homestead, flowering and fruiting July 29, 1910, Rock no. 8012 in the herbarium of the College of Hawaii.

Sophora chrysophylla was first recorded from Lanai, by the writer, and published in his book on "The Indigenous Trees of the Hawaiian Islands." The Lanai plant is certainly worthy of varietal rank and may be classed with Asa Gray's var. *β glabrata*. To this latter variety Asa Gray referred specimens from the lowlands of Hawaii. The writer observed *Sophora chrysophylla* as low as almost sea level at Puuwaawaa, North Kona, and elsewhere on Hawaii.

The plant from the lowlands of Hawaii belongs in all probability to Gray's var. *β glabrata*, but differs from the Lanai specimens in the much broader winged pods, while the plants from Lanai have wings only one millimeter in width. The variety



SOPHORA CHRYSOPHYLLA GLABRATA Rock
Mamani.
Growing on the lava flows of Puuwaawaa, North Kona, Hawaii;
elevation 2000 feet.

glabrata is always a shrub. It is peculiar to the arid ancient lava flows, where it grows in company with *Myoporum sandwicense, Nototrichium sandwicense, Dracaena aurea, Charpentiera obovata, Santalum Pilgeri* var. *luteum, Pittosporum Hosmeri, Rockia sandwicensis,* etc. At the same elevation on the slopes of Hualalai near Puuwaawaa occurs var. *unifoliata,* a much larger shrub or small tree, which may be described as follows:

Sophora chrysophylla unifoliata Rock var. nov.

A tall shrub or small tree, about six meters in height, with more or less straight branches, leaves simple not pinnate, broadly ovate-oblong up to 4.5 cm. long, 2.5 cm. wide, alternate on the woody branches, on petioles of 2-3 mm., finely pubescent on both sides; floral racemes terminal, pedicels 10-13 mm.; flowers small, pale yellow; calyx small 4 mm. high, pubescent, the lobes very broad and blunt; ovary densely pubescent; pods not seen.

HAWAII: Mr. Young without further locality, 1913, in the herbarium of the College of Hawaii, no. 12648;—Puuwaawaa, slopes of Hualalai, on old aa (rough) lava flow, elevation 2000 feet, flowering August 1917, Rock type no. 13011 in the herbarium of the College of Hawaii.

This variety was first discovered by Mr. Young of the fibre textile department of the United States Department of Agriculture. The writer met with a single tree at Puuwaawaa. Not one single pinnate leaf could be found on the tree.

ERYTHRINA L.

Guppy in his interesting work on seed dispersal ("Observations of a Naturalist in the Pacific") takes the viewpoint of *Erythrina monosperma* Gaud., the Hawaiian wiliwili, as having been derived from *Erythrina indica,* a widely-distributed species. This assertion would mean that *Erythrina monosperma* must have been once upon a time a shore species with buoyant seeds, and later became an inland species whose seeds lost their floating power due to location and environment.

Guppy simply quotes Drake del Castillo in regard to the rela-

PLATE XV.

Type of **Sophora chrysophylla unifoliata** Rock in herbarium College of Hawaii.

tionship of *E. monosperma* to *E. indica*, saying that the former is very nearly related to the latter and that the former differs from the latter mainly in the more hairy calyx, in the more permanently tomentose and much shorter pod, and in the paucity of seeds (one or two in number).

This viewpoint as regards relationship, the writer cannot share, and if Guppy had compared the pods of *Erythrina indica* with those of *E. monosperma* he could not have followed Drake del Castillo and adopted his statements without question. There is a very decided difference in the pod of *Erythrina monosperma* as compared with *E. indica*. The former dehisces on the tree, exposing the bright red (scarlet) seeds for a long time as they are firmly attached to the funis; the pod itself is hard and of a woody texture. When thoroughly mature the valves dehisce by becoming spirally twisted due to the heat of the sun, which shines from a cloudless sky wherever *Erythrina monosperma* occurs. In *Erythrina indica* the pod consists of a thick papery pulp which drops to the ground in its entirety, where it rots, but does not dehisce on the tree, and at no time are the seeds exposed while the pods hang on the tree, which is for a considerable period; the pods are indehiscent, thicky fleshy when green, the valves of which acquire the consistency of a thick papery pulp at maturity. The seeds are of a very dark brownish-carmine color, which hardly would attract birds. The Hawaiian species, however, with its scarlet seeds exposed for a considerable period in the bright sunlight, must certainly attract birds. The mature dehiscent seedpods exposing these bright red seeds can be seen from a considerable distance, while even the large but somber pods of *E. indica* are discernible only at close range.

According to Drake del Castillo, *E. monosperma* occurs in Tahiti and also New Caledonia; in the former island it inhabits the valley of Fautana at 2100-2400 feet elevation. It is, however, not the only species of *Erythrina* in Tahiti, as *E. indica* occurs on the beaches as a native tree.

Had *Erythrina monosperma* been derived from *E. indica*, and if the former was dispersed in bygone ages by means of ocean currents, why is it that the ancestor *E. indica*, which still has its buoyant seeds, is absent from Hawaii? And why is the satellite *E. monosperma*, with non-buoyant seeds, present in Hawaii?

The answers to these questions seem not to be difficult, especially after comparing the characters of the pods of the two species.

There is no doubt that *E. monosperma* is a much older species than *E. indica*, and that it belongs to a period of dispersal much antedating that of *E. indica*. On comparing the other species of plants found on the islands of the Eastern Pacific, especially of Tahiti, the Tonga and Cook group, with those of the islands of the Western Pacific, we find that the former are much older and in many respects quite peculiar, and that the endemicity is much higher than that of the species occurring in the Western Pacific islands, which received their plant stockings mainly from the Malayan region. The absence of *Lobelioideae* and the peculiar ancient arborescent *Compositae* of Hawaii and Tahiti, in the Western Pacific, would confirm the theory that the Western Pacific regions are undoubtedly younger. This question has been thoroughly discussed by the writer in his monographic study of the Hawaiian *Lobelioideae*.

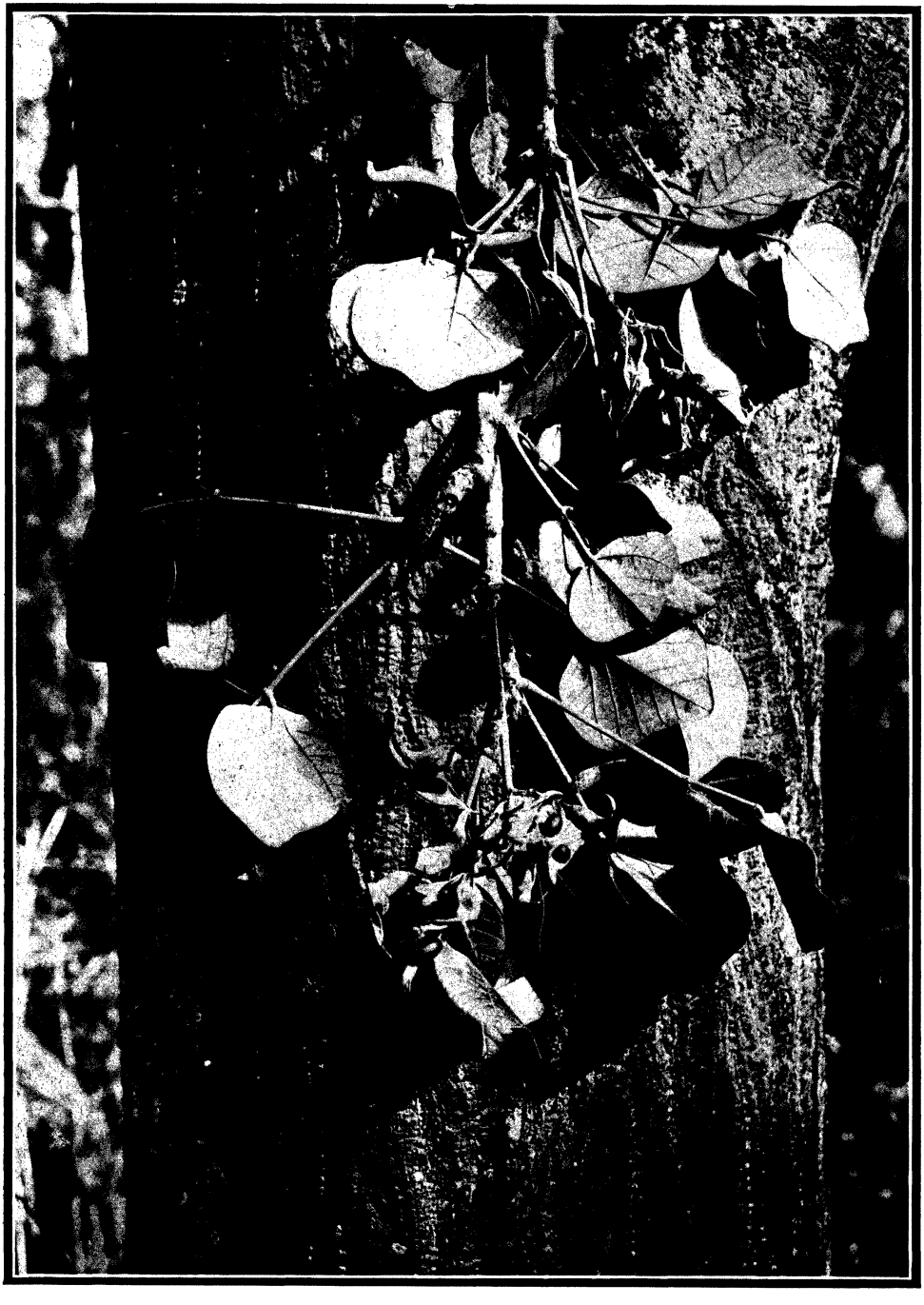
That *Erythrina monosperma* was dependent on birds for its dispersal is very probable, though the agent responsible for its distribution has long since passed out of existence. The peculiar dehiscence of the pod of *E. monosperma* on the tree, exposing the bright scarlet glossy seeds for a considerable period, would certainly indicate bird dispersal, as it would undoubtedly attract birds.

Guppy's contention that the seeds would swell too quickly if swallowed by a bird, and thus destroy the germinating power, is not correct, for seeds of that species may remain for weeks in water without the seed coating being destroyed or even wrinkled. The writer had seeds of *Erythrina monosperma* planted for months before they germinated, though they were kept in a hot moist atmosphere. Some, of course, germinate rather quickly, while others are extremely slow.

Erythrina monosperma Gaud. Bot. Voy. Uranie, 486, pl. 114. 1826.

Erythrina montana Forst. in Pancher, Herb., et in Cuzent, Tahiti, 240. 1860.

Erythrina tahitensis Nadeaud Enum. no. 499. 1873.



ERYTHRINA MONOSPERMA Gaud.

Wiliwili.

Showing trunk, bark, and fruiting branch. Lava fields near Puuwaawaa, Hawaii; elevation 2000 feet.

Corallodendron monospermum O. Ktze. Rev. Gen. Plant I:173. 1891.

A tree 6-10 m. high, sparsely aculeate with short conical prickles; trunk short or occasionally 5 m. long and vested in a thin yellowish bark with longitudinal ridges; crown broad spreading, with glabrous, stiff, gnarled branches, fulvo-tomentose at their ends; leaflets ovate-deltoid, broader than long, 5-6.5 cm. long, 6.5-9 cm. wide, obtuse, entire, truncate to subcordate at the base, chartaceous, tomentulous beneath; the petiole 8.5-25 cm. long, extending considerably beyond the lateral leaflets, petiolule of the terminal leaflet about 1 cm., that of the lateral ones about 5 mm. and articulate; stipules gland-like, one or two for the base of the petiole, one for each lateral and two for the terminal petiolule; racemes in the axils of the ultimate leaves, fulvo-tomentose, stout when with fruit, but often slender when with flower, nodose in the upper third, with one or two or three flowers at each node, 8-15 cm. long; bracts triangular, 2 mm. or less; pedicels 4-8 mm. with flower, 10-12 mm. with fruit; calyx thickly tomentose tubular-spathaceous, minutely toothed, 15 mm. or more long; standard 2.5 cm. in diameter (up to 5 cm. teste Hillebr.), scarcely stipitate; wings oblong obtuse 12 mm. (up to 18 mm. teste Hillebr.); keel 10-16 mm., its two petals free; stamens as long as the standard, the alternate ones shorter, that opposite the standard connate at the base; anthers pointed versatile; ovary tomentose, stipitate, three to five-ovuled, narrowing to a slender straight or curved style 15-20 mm. long; pod torulose, pubescent acuminate at both ends, coriaceous-ligneous, dehiscent 1- several-seeded; seeds scarlet or darker red, 15 mm. long, hilum elliptical 5 mm.; flowers brick red, orange or pale yellow.

KAUAI: Makaweli gulch, fruiting March 3-10, 1909, Rock no. 2156 in herbarium College of Hawaii.

OAHU: Koko Head, Rock no. 5839 in herbarium College of Hawaii.

MOLOKAI: Mahana, west end, fruiting March 1910, Rock, in herbarium College of Hawaii.

MAUI: Auahi-Kahikinui, southern slopes of Haleakala, Rock, in herbarium College of Hawaii.

LANAI: Mauna Lei, flowering and fruiting July 13, 1910, Rock no. 8118 in herbarium College of Hawaii.

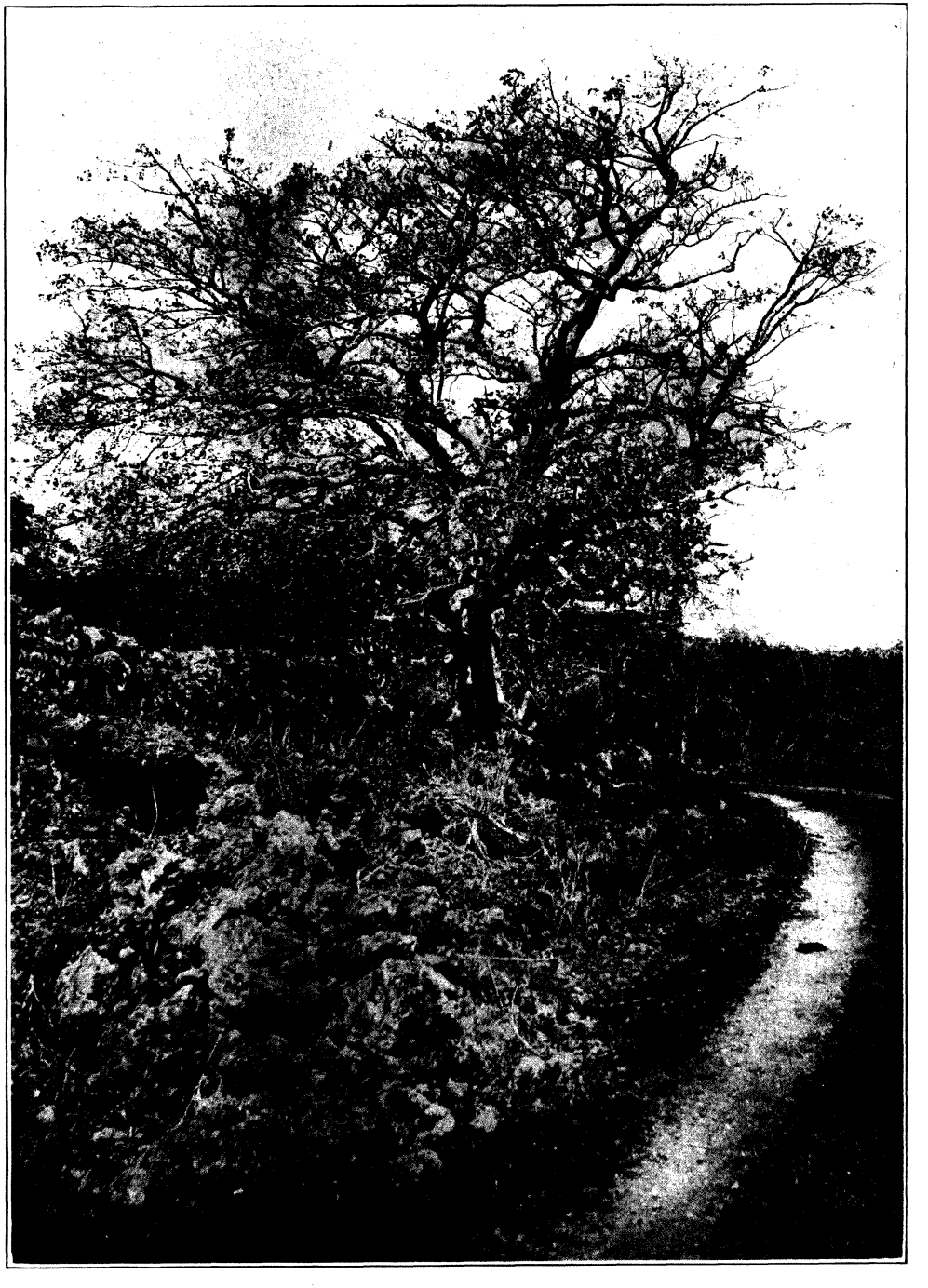
HAWAII: Puuwaawaa, N. Kona, Rock in herbarium College of Hawaii;—observed at Kapua, S. Kona, Naalehu, Hilea, Kau, etc.

KAHOOLAWE: Observed by R. S. Hosmer.

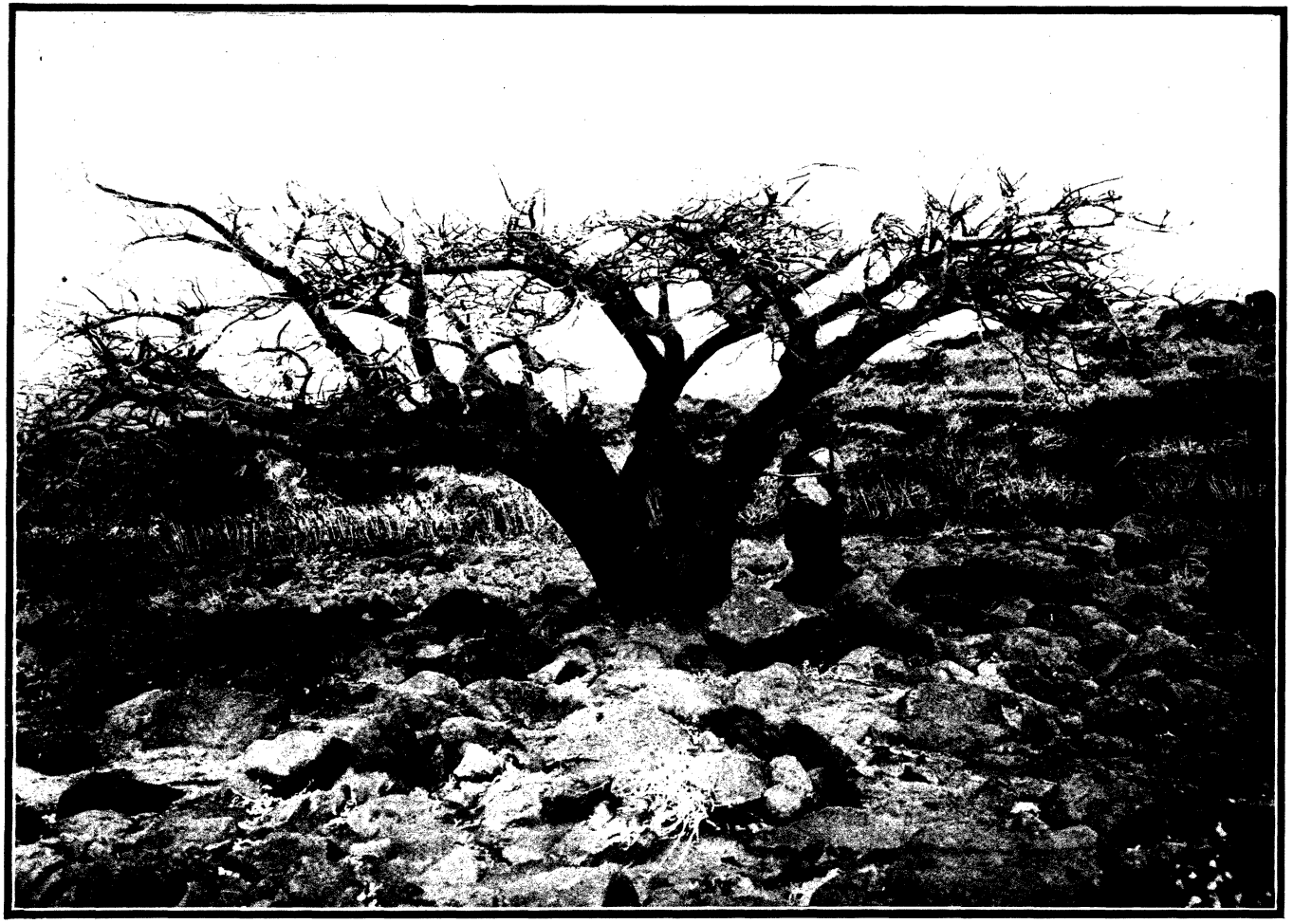
Specimens with pale yellow flowers were observed both on Lanai and Hawaii.

The native name of this tree is *Wiliwili*.

E. monosperma inhabits the dry regions on all the islands of



ERYTHRINA MONOSPERMA Gaud.
Wiliwili.
Growing on the lava fields of Puuwaawaa, North Kona, Hawaii; elevation 2000 feet.



ERYTHRINA MONOSPERMA Gaud. (**Wiliwili**), the only native tree species left on the barren island of Kahoolawe.

the archipelago. It occurs from about 500 feet elevation to 2000 feet, but rarely higher. It loves the hot arid lava flows, and is always found on the leeward side and never on the windward side of the islands. On Kauai it may be found in Waimea canyon, the rocky slopes back of Kekaha and Waimea, and also on the drier part of the Haupu range. On Oahu it is common in the valleys of the Waianae range, as at Mokuleia, etc., also on the extreme eastern end of the Koolau range at Wailupe, Niu and Koko Head. On Molokai it occurs back of Kaunakakai, and must have been very common all over the western end of the island, where it still occurs in clumps or as isolated individuals in dry canyons. It is associated with *Reynoldsia sandwicensis, Gardenia Brighami, Plectronia odorata, Xylosma Hillebrandii, Kokia drynarioides, Osmanthus sandwicensis, Breweria Menziesii, Maba sandwicensis, Chrysophyllum polynesicum* and *Nototrichium sandwicense.* On Maui it is not uncommon back of Makawao and especially so on the southern slopes of Haleakala at Auahi and Kahikinui, where it grows with some of the species above mentioned and *Rauwolfia sandwicensis,* species of *Pittosporum, Alectryon macrococcus, Pelea Knudsenii* var. *multiflora* and others. On Lanai it can still be found on the slopes back of Manele, as well as in the deep and arid gorges of Mauna Lei and Nahoku, also in the desert region of Kaa. On Hawaii it is still most numerous, especially on the lava flows of both North and South Kona and Kau. It forms practically a belt around that part of the island, beginning at Hilea, through Manuka, Kapua, Honomalino, Papaa, Kealakekua, Huehue, Puuwaawaa to Puuanahulu, Kawaihae-uka and Puukawai near Waimea. Its associates in Kona are *Mezoneurum Kauaiense, Dracaena aurea, Charpentiera obovata* var., *Alphitonia excelsa, Colubrina oppositifolia, Kokia Rockii, Sideroxylon auahiense* var. *aurantium, Pittosporum Hosmeri* and its variety *longifolium.* In the Kona district it develops huge trunks of several feet in diameter, which are of a dirty orange yellow; the flowers are either red, brick red, yellowish or white. The trees are often festooned with *Canavalia galeatea* var. *pubescens.* Even the island of Kahoolawe still supports a few trees of this species, about the only native tree in existence there.

It is on the islands of Kauai, Molokai and especially Oahu that

the tree is on the verge of extinction, while on Hawaii it is still abundant owing to the uselessness of the land on which it grows, being mainly found on rough *aa* lava flows inaccessible to cattle, the arch enemy of Hawaiian trees and forests in general.

The wood of the *Wiliwili* is soft and very light, and was used by the Hawaiians for the float in the outrigger of their dug-out canoes.

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BOTANICAL BULLETIN No. 6. JUNE, 1919

Territory of Hawaii
BOARD OF AGRICULTURE AND FORESTRY

DIVISION OF FORESTRY
C. S. JUDD, *Superintendent*

The Hawaiian Genus Kokia

A RELATIVE OF THE COTTON

BY

JOSEPH F. ROCK
Consulting Botanist

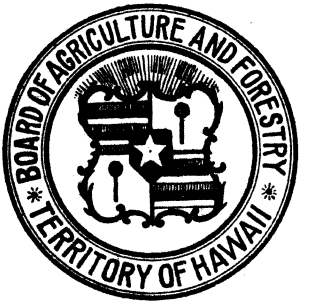

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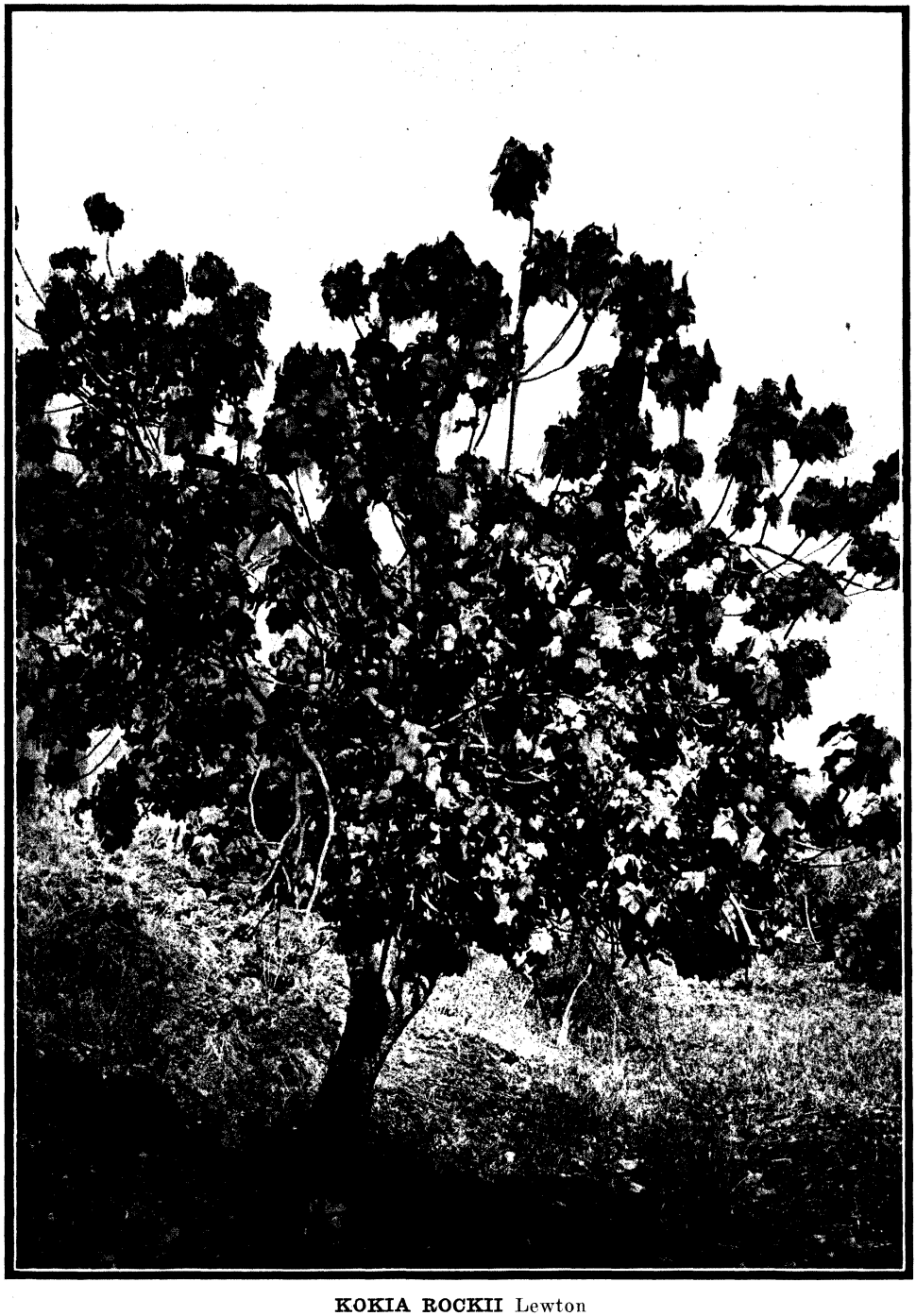
PLATE I. (Frontispiece)



KOKIA ROCKII Lewton
Kokio tree.
Growing on the lava flows of Puuanahulu, Kona, Hawaii; elevation 2500 feet.

BOTANICAL BULLETIN No. 6. JUNE, 1919

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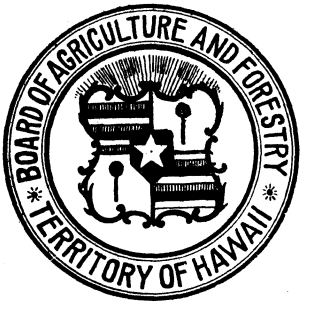

ISSUED JUNE 9, 1919
HONOLULU, HAWAII

LETTER OF TRANSMITTAL

HONOLULU, HAWAII, May 3, 1919.

Board of Commissioners of Agriculture and Forestry,
Honolulu, Hawaii.

GENTLEMEN:

I have the honor to transmit herewith the manuscript of a paper entitled "The Hawaiian Genus *Kokia,* a Relative of the Cotton," by Mr. Joseph F. Rock, *Consulting Botanist of the Division of Forestry* and also *Botanist of the College of Hawaii,* and to recommend that it be published as Botanical Bulletin No. 6 of the Division of Forestry.

The paper treats of the very rare members of this most interesting genus of which one species has already become extinct, and it is hoped that its publication will arouse interest in the preservation and cultivation of these rare species.

Very respectfully,

C. S. JUDD,
Superintendent of Forestry.

Approved:
Board of Commissioners of Agriculture and Forestry,
May 5, 1919.

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THE GENUS *KOKIA* IN THE HAWAIIAN ISLANDS.

In the year 1912 Fredrick L. Lewton* established the genus *Kokia*, based on material furnished him by the writer of a species of a tree belonging to the family *Malvaceae*.

The genus as understood by Lewton consists of three species, viz: *Kokia Rockii*, the type of the genus; *Kokia drynarioides*, and *Kokia lanceolata*.

Kokia Rockii was first discovered by the writer in June, 1909, although the tree was well known to the old natives of the island of Hawaii and particularly to the natives of North Kona, to which locality the species is peculiar. When the species was first found by the writer he thought it to be identical with a closely related species occurring on the dry, west end of Molokai, where a species of that genus was first collected by Nelson, the companion of Captain Cook. The specimens collected at that time were quite fragmentary and were described by the celebrated botanist Berthold Seeman in the genus *Gossypium* under the specific name *drynarioides*.

To Dr. Hillebrand belongs the credit of finding another species, but not so recognized by him, on the eastern end of the island of Oahu. The specimens in existence are extremely meagre and fragmentary. It was listed in his famous work on the "Flora of the Hawaiian Islands" as a variety β of *Gossypium drynarioides* Seem. Prof. Lewton, whom the writer furnished with material of two species, the Hawaii and Molokai species, correctly recognized the species as not belonging to the genus *Gossypium*, but to a new genus "*Kokia*," closely related to *Gossypium*.

The genus was then only known from Oahu, Molokai and Hawaii.

On April 2, 1919, Mr. Augustus F. Knudsen of Kekaha, Kauai, an ardent naturalist like his father Valdemar Knudsen, from whom Dr. William Hillebrand received all his Kauai botanical material, addressed a letter to the writer, and enclosed some

* Lewton, Frederick L. Kokia. A new genus of Hawaiian Trees. Smithsonian Misc. Coll., Vol. 60, part 5, Oct. 22, 1912.

fragmentary specimens with the request to identify the same. He stated: "It is the only tree of its kind known to me on Kauai." The specimen sent was immediately recognized as belonging to the genus *Kokia*. The enthusiasm of a botanist may be imagined at the finding of such a rare and beautiful species of the genus *Kokia*. The writer immediately sent a wireless stating that he would appear on Kauai by the next boat. The specimen sent by mail was too fragmentary to permit the identification with any of the three known species.

The occurrence of a species of *Kokia* on Kauai confirms the belief that the genus was spread over the whole group and was probably also present on Maui and Lanai and perhaps Niihau and Kahoolawe. The *Kokia* trees have numerous enemies, the worst being cattle, which feed on the succulent leaves and fleshy branches, while the natives stripped off their bark for the sake of a dye which they extracted for the preservation of their fish nets.

The writer, accompanied by Mr. A. F. Knudsen and his brother, Mr. Eric A. Knudsen, immediately on arrival mounted horses in search of the tree. The tree could not be located by anyone not familiar with the country, no matter how detailed a description of the locality might be given. The party climbed the cliffs of Mana, the extreme western end of Kauai, composed of barren volcanic cliffs, the main vegetation of which is composed of the *pili* grass, *Andropogon contortus*. After a ride of several hours, crossing gulch after gulch, the party arrived at the canyon of Koaloha, in which is located the only *Kokia* tree now known from Kauai. It grows in company with the *Kukui, Aleurites moluccana,* whose leaves the *Kokia* greatly resemble, making it very difficult to distinguish the tree from the *Kukui,* especially at a distance.

The Kauai *Kokia,* which is a tree about 30 feet in height, owes its survival to a cliff about 15 feet in height on the edge of which it grows, the trunk and crown inclining over the cliff so that cattle can not reach it.

Mr. Knudsen informed the writer that he saw the identical tree 20 years ago, but that he could not locate it again until he stumbled onto it in a recent cattle drive.

The tree was full of flower buds, none of which had opened,

but one was just about to open. Specimens were collected and the ground was searched for a whole hour in an effort to find mature seeds. Seven seeds were found in all, including a perfectly mature capsule.

Mr. Knudsen states that he has seen the tree loaded with flowers, about 2000 flowers being observed at one time, each individual flower being from seven to nine inches across. The flowers are of a brilliant red, and when the tree is in full bloom it is an object of great beauty.

On examination it was found that the tree is related neither to the Molokai nor to the Oahu species, but is exceedingly close to *Kokia Rockii* of Hawaii, from which it differs sufficiently in size of flowers, leaves, pubescence, capsule, etc., to make it worthy of a varietal rank. It is therefore here named as *Kokia Rockii Kauaiensis.*

History of the Old Species.

As has already been stated, *Kokia drynarioides* was discovered by Nelson, the companion of the great circumnavigator Captain Cook, and was described by Seeman* very briefly in his "Flora Vitiensis." Dr. William Hillebrand received specimens of this species from a Mr. R. Meyer, an old resident of Molokai, who discovered three trees which could not be located again by Dr. Hillebrand. In April, 1910, the writer found a single tree of that species in a lonely, dry canyon at the extreme west end of Molokai back of Mahana. It was a small, stunted tree about 10 feet in height. Although it was full of fruit and leaves, it showed signs of decay, so that the passing of a year or so would find the species extinct.

The region in which this rare species grew is one of the weirdest and loneliest imaginable. The tree stood on a rocky bluff all by itself. Some distance from it there were the remnants of a forest, a few scattered trees of *Osmanthus sandwicensis, Nototrichium sandwicense, Xylosma Hillebrandii, Maba sandwicensis, Chrysophyllum polynesicum* and the exceedingly rare vine *Breweria Menziesii,* which clinged for support to an old decaying

* Seeman in Fl. Vit. 22. 1865.

KOKIA ROCKII Lewton
Kokio.
Flowering branch, flowers bright red of silky texture. About one-third natural size.

PLATE III.

KOKIA ROCKII Lewton

Fruiting specimen pinned against trunk of tree.

Maba tree. All the trees were windswept, the crowns extending in oblong outline in one direction. On the ground lay scattered old trunks of once glorious trees, and among them a small dead tree of *Kokia drynarioides,* probably one of the original three trees discovered by R. Meyer, and perhaps the very same from which Nelson collected his fragmentary specimens.

In June, 1915, the writer made another visit to the then only living tree of *Kokia drynarioides.* It was nearly dead, only one or two branches still bearing foliage. There were neither flowers nor fruit on the tree. A search on the ground rewarded the writer with a few seeds, some of which were grown in Honolulu, and one of which was planted on Molokai by Mr. C. C. Conradt, at Pukoo. The rest were forwarded to Mr. David Fairchild, Agricultural Explorer of the Bureau of Plant Industry at Washington, D. C.* Unfortunately, the seedlings grown in Honolulu died on account of the excessive rains during the winter of 1915-16.

While on Molokai in 1918 the writer visited the tree again, but it had died; only the worm-eaten, barkless trunk and branches remained of the last of its race.

There are now two living trees in cultivation on Molokai. One is at the residence of Mr. C. C. Conradt, at Pukoo, where the tree has already flowered and fruited for the first time this spring (1919), four years after planting from seed. The other is at the residential grounds of Mr. Geo. P. Cooke. This latter tree is older than the Pukoo tree, but is now beginning to flower for the first time. It grows at an elevation of about 2000 feet.

A few seeds secured from the Pukoo tree have been planted in Honolulu with the hope of getting it established here. Two seeds were sent to Mr. Fairchild.

Kokia lanceolata Lewton

No living specimens of this species are in existence. While in Europe in 1914, the writer worked on the Hillebrand collection at Dahlem, and through the kindness of Prof. Engler secured many duplicates from Hillebrand's herbarium, among them a

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* In a letter dated April 23, 1919, Mr. Fairchild writes: "You will be interested to know that we have a plant about five feet tall growing vigorously at our garden at Buena Vista, near Miami, Florida."

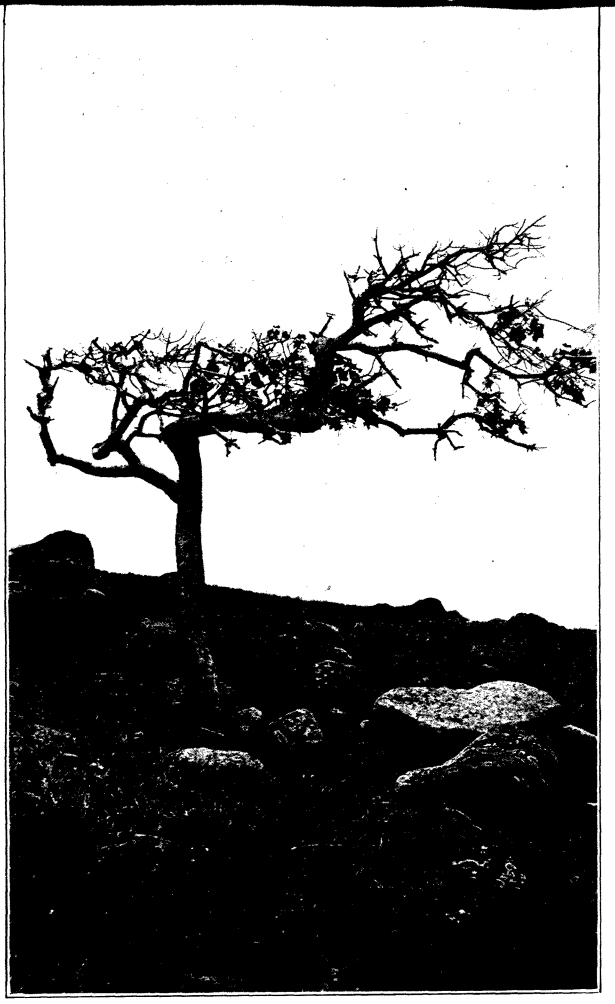

Fig. 1. **KOKIA DRYNARIOIDES** Lewt.

The last of the Molokai Red Cotton as it appeared in 1915. It is now a thing of the past.

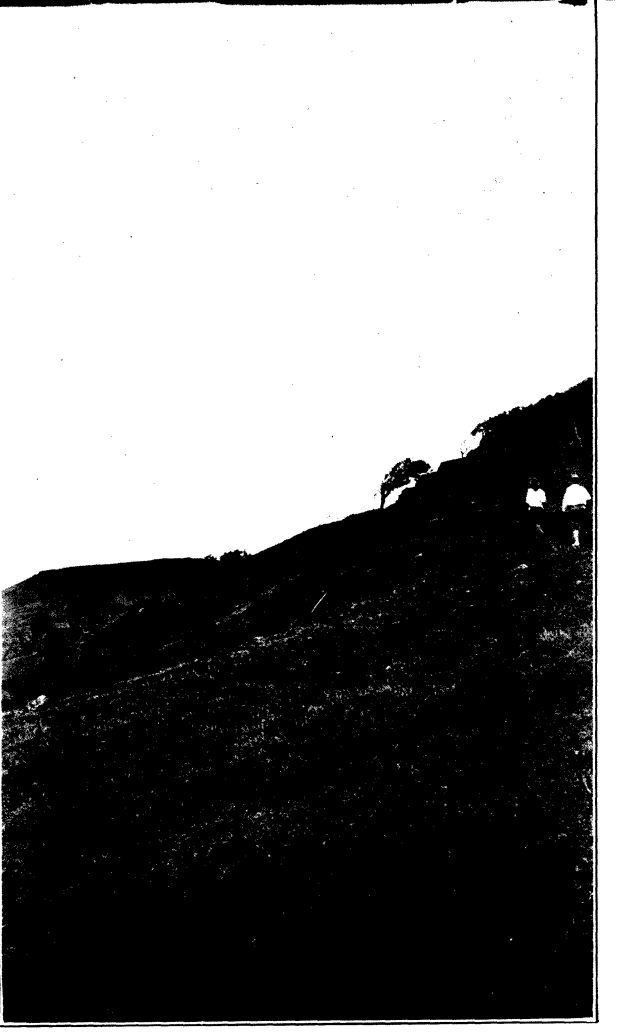

Fig. 2. The region on the west end of Molokai (Mahana) where the Red Cotton grew.

specimen of *Kokia lanceolata*. While the specimen is fragmentary, it is practically the best in existence. It was collected by Hillebrand on the island of Oahu in the valley of Wailupe, at the eastern end of the island. The writer searched Wailupe to find the species again, but without avail.

The leaves of *Kokia lanceolata* differ considerably from those of *Kokia Rockii* and the other species and variety. They are not cordate, but subtruncate at the base and without a sinus. The bracts are narrow, lanceolate. No flowers or fruits are extant of this species.

Kokia Rockii Lewton

A number of trees of this species are still in existence. They grow in the dry district of Puuwaawaa, North Kona, Hawaii, on rough *aa* lava flows.

Mr. Robert A. Young and Mr. Paul Popenoe published an article on "Saving the *Kokio* Tree" in the Journal of Heredity of January, 1916.*

The writer regrets to relate that the protective measures undertaken or supposedly undertaken to save that species were never thoroughly carried out, due to lack of interest on the part of the owners or lessee of the land and the Government in general. It is true that a few walls of lava rock were erected around a couple of trees or so, but so close to the trunk that the inner margin of the wall was not more than a foot distant from the trunk. Since then the walls have fallen down, due to the rummaging of cattle and goats, and the trees are as unprotected as ever.

One tree of this species has been planted on the College of Hawaii grounds, where it has reached the height of six feet, and seems well established. Others are being grown to be planted out at the College arboretum.

Kokia Rockii **Kauaiensis** *Rock* n. var.

An erect tree about 10 m. high, with ascending branches; leaves

* Saving the Kokio Tree. Robert A. Young and the Editor "The Journal of Heredity," Vol. 7, No. 1, January, 1916.

in whorls at the ends of the branches, somewhat fleshy of a deep green color, palmately 10-nerved; the leaves orbicular in outline with broad deltoid obtuse lobes 8 to 10 in number, the intervening sinuses very shallow, the leaf bases overlapping dextrorsely and sinistrorsely, 15 to 25 cm. in diameter, covered with a transparent areolar network and punctate throughout with blackish dots, glabrous above and beneath, but hirsute on both sides, with yellowish brown hair at the place of attachment of petioles; petiole fleshy thickly punctate with black dots, 5 to 8.5 cm. long; flowers single in the axils of the leaves; peduncle stout, 3 to 4 cm. long, bracteolate below the middle; the three bracteoles persistent, sessile broadly ovate sinuate, chartaceous, greenish red in color, more or less prominently nerved, glabrous above, hirsute with scattered yellowish hair beneath, especially along the middle of the bract, 15 cm. long, 13 cm. wide, each bract free to the base, the broad bases overlapping; calyx densely hirsute with yellowish hair, the ring of stiff brownish hair at the base of the calyx tube missing; flowers up to 22 cm. in diameter (teste A. Knudsen), bright red, the petals densely silky pubescent outside with yellow hair; capsule larger than in *Kokia Rockii,* ovoid, 3.75 cm. high, woody, acuminate; seeds broadly angular, larger than in the species, lint longer.

KAUAI: Koaloha Canyon, region of Mana, in company with *Aleurites moluccana, Nototrichium viride, Osmanthus sandwicensis,* etc., flowering and fruiting April 12, 1919, Rock and Knudsen no. 16037, type, in herbarium, College of Hawaii.

This variety differs from the species in the larger leaves and flowers, the larger ovoid-oblong capsule, the densely hirsute calyx and in the absence of the ring of stiff brownish hair at the base of the calyx tube.

Kokia lanceolata Lewt.

Gossypium drynarioides var. β Hillebr. Flora Haw. Isl. 51. 1888.

Kokia drynarioides lanceolata (Lewt.) Rock Indig. Trees Haw. Isl. 307. 1913.

Leaves much smaller than in the other species, 12.5 cm. wide, 7.5 cm. long, deeply sinuate, the middle lobes 3.75 cm. long, the lower lobes diminishing in size towards the base, the last lobes

KOKIA ROCKII KAUAIENSIS Rock
(Reduced.)

KOKIA ROCKII KAUAIENSIS Rock, with its discoverer,
A. F. Knudsen.
The tree, the only one known from Kauai, grows in the dry canyon of Koaloha in the Mana region of Kauai.

widely separated by a broad sinus, (base subtruncate) instead of overlapping as in the other species; petiole 13.75 cm. long; peduncle less than 5 cm. long, bracteate below the middle, the three bracts below the calyx tube, lanceolate, 3.75 cm. long, 12.5 mm. wide, glabrous above, pubescent beneath, several nerved, the veins parallel; calyx tube broadly campanulate, glabrous, shining, but with scattered black warts as in the other species; flower bud, densely hairy with yellowish silky hair outside.

OAHU: Wailupe Valley, Hillebrand in Herbarium Berlin and College of Hawaii Herbarium no. 16041.

Hillebrand, who collected this rare species, reports it from the eastern end of Oahu on the hills of Makaku and Koko Head. Two trees were seen by him. The specimen in the Berlin Herbarium is labeled as coming from Wailupe Valley. There is no doubt that this interesting species has become extinct, as a careful search of the eastern part of Oahu, including Wailupe Valley, was without success.

Hillebrand himself expressed the fear that this rare tree was doomed to extinction owing to its being accessible to cattle.

CONCLUSION.

It is remarkable that the Hawaiian Islands should have contributed two endemic genera to the not very large family *Malvaceae*. One is the present genus *Kokia,* the other the genus *Hibiscadelphus.*

Of other *Malvaceae* the Islands possess a number of endemic species, the most interesting being the various species of *Hibiscus.* The most noteworthy genus next to *Hibiscadelphus* is the genus *Kokia,* and perhaps more so, since the members of the genus *Kokia* may prove to be of economic importance. In the article on "Saving the *Kokio Tree,*" by Young and Popenoe, these authors state: "In itself it appears to have no economic importance; but since the rise of the science of genetics has given breeders such a keen realization of the value of the wild relatives of important cultivated plants, it was possible that this wild cotton should escape consideration as of possible value in hybridization with the low-growing species commonly cultivated. But when the attempt was made to get this tree-cotton it was found to be

Ex Museo botanico Berolinensi.

Kokia drynarioides

Oahu Wawiepe.

COLLEGE OF HAWAII HERBARIUM

KOKIA LANCEOLATA Lewton

almost too late. There was grave doubt as to whether the tree could be saved from absolute extinction. It is the purpose of this paper to describe the measures by which an exceedingly rare plant of great interest has been saved from perishing altogether."

In concluding their article the authors state: "It is to be hoped that equally successful efforts will be made to save other wild relatives of cultivated plants, not only from sentimental reasons, but because any one of them, even the least promising in appearance, may turn out, in the hands of plant breeders, to be of great value to the world's agriculture."

The writer would recommend that steps be taken immediately, not only to protect properly the present living trees, but also to make arrangements whereby the seeds of these valuable trees are collected every year for the purpose of propagation. Young plants should be set out in some of our dry forest reserves, or even back of Honolulu, on Tantalus or Punchbowl, as these trees thrive well at lower elevations in hot, dry situations.

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